Railway Mechanical Engineer

VOLUME 90. NUMBER 11. ESTABLISHED IN 1832

NEW YORK: Woolworth Building
CHICAGO: Transportation Building
New York—NOVEMBER, 1916—Chicago
CLEVELAND: Citizens Building
WASHINGTON: Home Life Building

Railway Mechanical Engineer

Volume 90 November, 1916 No. 11

Our Prize Competitions

The number of papers received in the competition on hot boxes on freight cars was so large that the judges have been unable to come to a decision as to the winners in time for publication in this issue. The papers are said to discuss the subject from widely different viewpoints and therefore promise to be of exceptional interest and practical value. The closing date for the competition on the benefits received from convention attendance was still two days off when we closed our forms, but the number of contributions received up to that time indicated an interest which, we hope, will mean much for the strengthening and enlarging of mechanical department associations. The educational value of these organizations is undoubtedly responsible for much of the rapid progress which has been made in the motive power and car departments during recent years.

Higher Officers, Attention!

Do you know what the Chief Interchange Car Inspectors' and Car Foremen's Association is doing? Do you realize the importance of its work? Are you aware of the fact that it is a most important adjunct to the M. C. B. Association? If you do, why not show your appreciation and interest by attending one of the sessions of its annual convention? The inspiration it will give the members will well repay your road in dollars and cents. The presence of such men as F. W. Brazier, W. O. Thompson and A. LaMar at the Indianapolis convention last month was deeply appreciated by the officers of the association and every member in attendance. Many other of the higher mechanical and operating officers, particularly in the section of the country in which the meeting was held, might easily have made it possible to attend if they had realized the effect their presence would have. This is true also of the other mechanical department associations. It is poor policy for any officer to so busy himself with details that he cannot find time to keep in intimate touch with his subordinates. Here lies his greatest opportunity for producing results, and yet how many seem to overlook it. Lending a hand and helping to inspire those in attendance at the minor railway mechanical department conventions is one means of attaining this end and is sure to bring results.

The Value of the Shop Band

Asked what had been the most important development within the past year at a large railroad shop with which he was connected, the shop foreman replied without hesitation: "The starting of our shop band. It seems to have stirred our fellows up to a higher degree of loyalty. It has developed a number of boosters who are in no way connected with the band. The fellows are taking a greater pride in being connected with the shop and the road, and I imagine I can see more team work among our men as individuals and between the various departments of the shops." This is pretty strong testimony. It is hard, however, to discount the effect of seven bands at the big Erie celebration and field meet at Huntington, Ind., last August; or of the presence of half a dozen or more bands at the annual outdoor athletic meet of the Pennsylvania Railway at Altoona, Pa., on September 30, when the Altoona car shop base ball team beat Philadelphia Terminal before a crowd of 21,000 or more, thus winning the system championship; or of thousands of boosters from all over the Missouri, Kansas & Texas who were inspired by several shop bands at the big field meet at Parsons, Kan., on October 7, when the Sedalia, Mo., ball team won the system championship by beating Smithville, Tex. A good band, or even a very ordinary one, is one of the little things that will do much to build up the greatly to be desired spirit of enthusiasm and loyalty in an organization.

The Two Convention Stories

The reports of the conventions of the Traveling Engineers' Association and the Chief Interchange Car Inspectors' and Car Foremen's Association, which will be found elsewhere in this issue, cover only the proceedings of the first half of these two important meetings. The remainder of the proceedings of both conventions will be reported in our December issue. Two reasons are responsible for this deviation from our usual practice. To cover fully the Traveling Engineers' meeting, which was held during the last week of October, it would have been necessary to delay the publication of this number. Then, too, we have found it advisable to carefully study the balance of each number. By "balance" we mean that each issue is carefully designed to present such a variety of material as to meet the needs of each of the various classes of men who are numbered among our readers. We could only include complete reports of these two meetings by crowding out other material of special interest and value to those who may not be particularly interested in either one of these two conventions. In the case of the Chief Interchange Car Inspectors' and Car Foremen's Association we have included a running report of the convention with abstracts of the special addresses which were made, and an account of the discussion of the Rules of Interchange. This leaves for consideration in the next issue the prize stories on car department apprenticeship, and the several individual and committee reports which are an entirely new feature in the work of this organization.

Loss and Damage to Freight

Defective freight car equipment is responsible for a considerable percentage of the loss and damage to freight, both directly and indirectly through pilferage and wrecks. Great strides have been made in reducing this loss in recent years, a series of articles on Defective Box Cars and Damaged Freight in the Railway Age Gazette, during April and May, 1912, being an important factor in

awakening railway officers to the true situation. Much still remains to be done in making further reductions. Car inspectors especially are in a position to see and study conditions which are responsible for these losses. If you find a cause of loss or damage and make a practical suggestion to remedy the difficulty, do not become disheartened and disgusted if your suggestion is not immediately acted upon. Keep right after the wrong condition, if it is of sufficient importance, until something is done to remedy it. A wise college professor used to tell his boys that if they were fighting in a good cause, to keep pegging away until they made an impression. "If you were to throw a handful of mud at a highly polished marble wall," he said, "it would not make much, if any, impression; only a small and insignificant portion might stick. But if you keep on, gradually more and more will stick until you finally cover the entire wall." A real executive officer cannot but admire a subordinate who will not be satisfied until he has put a good thing over, or if he is wrong, keeps at it until he is shown to be in the wrong.

The Eight-Hour Day Question

Several weeks have now elapsed since Congress at the request of President Wilson, and to avert a nation-wide strike of the men in railway train service, hurriedly passed the Adamson law. This law purports to be one to establish an eight-hour day in train service, but its language clearly shows that this is not its purpose or effect. It provides that "eight hours shall, in contracts for labor and service, be deemed a day's work, and the measure or standard of a day's work, for the purpose of reckoning the compensation of all employees who are engaged in any capacity in the operation of trains." This says, as expressly as it could be said, that eight hours is to be considered a day's work for only one purpose, and that is for the reckoning of compensation. Elsewhere the act provides that overtime after eight hours shall be paid pro rata, thus showing that it is contemplated that employees in train service shall continue to work more than eight hours. A commission to observe the workings of the law for six to nine months is created, and the same wages must be paid for eight hours as are now paid for ten hours until 30 days after this commission makes its report. The investigating committee recently appointed is of excellent personnel, being composed of General Goethals, the builder of the Panama Canal, George Rublee, who is a member of the Federal Trade Commission, and E. E. Clark, who is a member of the Interstate Commerce Commission.

Enough time has now passed since the Adamson law was enacted for sober reflection as to the significance of its enactment. It is well known that it was rushed through Congress chiefly to prevent the strike that was threatened. Nothing could be plainer than the fact that it does not establish an eight-hour day, but merely grants an increase of 25 per cent in wages to the class of railway employees who are the best paid already. It ignores the rights, the welfare, and even the existence of the other 80 per cent of railway employees. By forcing upon the railways an increase in the wages of the train service employees it necessarily renders it more difficult for the railway managements to make any concessions that they might otherwise have been able and willing to make to the rest of their employees, and to officers of those ranks who are directly in contact with the employees, such as shop foremen, road foremen of engines, master mechanics, etc. The Chamber of Commerce of the United States advocated the passage of a resolution by Congress providing for an investigation by the Interstate Commerce Commission of the conditions of work and wages of all railway employees, but this plan President Wilson and Congress unceremoniously threw into the discard.

The disregard of the rights and the welfare of a large majority of railway employees and of the public shown by the train service employees in threatening to tie up the transportation and commerce of the entire country, and by President Wilson and Congress in passing the Adamson law, are but too apparent. The labor brotherhoods are now openly seeking votes for President Wilson because of the course he took in connection with this matter. He certainly did not give the other employees of the railways any reason for feeling kindly or grateful to him.

Selection of Future Officers

Those who read the paper presented by F. W. Thomas, supervisor of apprentices of the Santa Fe before the October meeting of the New York Railroad Club, an abstract of which is printed elsewhere in this issue, will be impressed with the simple logic of not leaving to chance the selection and training of men who are eventually to occupy positions of more than ordinary responsibility. It is difficult to understand why more thought has not been given to this particular phase of the training of men. Judging from the methods usually employed, the theory seems to be that from the ranks there will automatically arise enough men of exceptional ability to fill the positions of responsibility as the needs arise. From the selection of men for the ranks upward, the entire problem is, therefore, left to chance. That this is very poor policy is proved by the frequency with which we see organizations forced to go outside their own ranks for officers, and especially in the mechanical department by the frequency with which the question is asked "What is the matter with the mechanical department?"

It is evident that if leaders are to be selected from the ranks, the right kind of men must be brought into the service at the bottom. But the solution of this problem alone does not necessarily insure the best results in the promotion of men. Leaving this to chance will often result in costly failures, which could have been avoided had a careful selection of the available material been made well in advance of the actual requirements. The selection from the ranks of recruits for promotion and the special training which is offered to them by the Santa Fe augurs well for the breadth of vision of its future mechanical department officers. Furthermore it serves a very important function which should not be overlooked. Mr. Thomas states that over 80 per cent of the men selected for the severe special course training, stick it through to the end. Presumably every man selected for this course is supposed to possess the qualifications necessary to meet future responsibility. Is it not far better to eliminate the 20 per cent who, for various reasons, give up under the strain of this training, before rather than after the effectiveness of the organization is seriously impaired by their failure?

Uniform Interpretation of Interchange Rules

One need only attend a meeting of the Master Car Builders' Association when the members are discussing the rules of interchange to realize the many complications that may arise in the application of these rules. And, by the way, the discussion of the rules by the members of the Chief Interchange Car Inspectors' and Car Foremen's Association does not suffer in comparison with similar discussion by members of the Master Car Builders' Association. It is quite apparent that these men are more familiar with the actual details of the work than are the men at the head of the mechanical department.

Will there ever be a strictly uniform interpretation of the application of the rules? Possibly, but a layman must necessarily be a little skeptical after listening to the discussion of the rules and the opinions expressed by what may be considered the cream of the car interchange inspector's profession. At any rate, it is readily apparent that the use of cheap men or the lack of training and educational work

among the inspectors is liable to prove a most costly practice on the part of any road which does not give studious and constant attention to these things.

Several contributors to the competition which the *Railway Mechanical Engineer* held last year on the qualifications and training of car inspectors emphasized the fact that they should have a fair understanding of the use of English and at least a common school education. Apparently they might have insisted on even more exacting requirements in this respect. It is surprising what the misunderstanding of the use of even a comma may cost a company in the misapplication of at least one of the rules. It may be advisable in the interests of a more uniform interpretation of the rules to give greater attention to the simplest possible wording of the rules, amplifying in some cases by the introduction of short sentences or explanations in parentheses, rather than to depend too greatly on the right understanding of a compound sentence by a man of comparatively limited education and practically no technical training. At any rate, it is beyond question that plentiful returns will follow any investment which will train and develop the inspectors and car foremen to a better understanding of the rules and regulations with which they must be familiar. Misinterpretation of the rules is liable to prove a very expensive proposition.

Car Department Apprentice Problem

Something is surely wrong when a car department officer will admit that desirable young men cannot be attracted to the car department because of lack of opportunity for advancement in that department. The following figures are for the year ended June 30, 1916, and include the larger roads which were first to issue annual reports for that period. It will be seen that with the exception of the Santa Fe and Southern Pacific the expenditures for repairs to freight and passenger cars are in all cases higher, and in some cases very much higher, than the cost of repairs to steam locomotives. Figures for repairs to freight and passenger cars do not include work equipment or repairs to electrical equipment on cars.

Road	Repairs to Steam Locos.	Repairs to Freight and Passenger Cars.
Atchison, Topeka & Santa Fe	$8,184,483	$5,908,818
Buffalo, Rochester & Pittsburgh	708,462	1,319,551
Chesapeake & Ohio	2,721,998	4,966,258
Chicago & North Western	4,700,785	6,118,310
Chicago, Milwaukee & St. Paul	5,809,104	7,491,970
Chicago, St. Paul, Minn. & Omaha	865,320	869,684
Lehigh Valley	3,039,037	3,135,789
Missouri Pacific	3,726,486	7,987,302
Norfolk & Western	3,189,180	3,851,418
Southern Pacific	3,280,565	2,596,367
Southern Railway	3,567,659	4,689,860

Confirming these figures we find that the Interstate Commerce Commission's statistics for the year ended June 30, 1914, show expenditures of $175,108,236 for repairs to steam locomotives on the part of those roads having a revenue of more than $1,000,000 a year. The repairs to freight and passenger cars for the same period amounted to $214,689,943, or 22 per cent more than for repairs to steam locomotives.

There are just as great—probably far greater—possibilities for savings in the car as in the locomotive department. Why is it not more important to devise means whereby capable and desirable young men will be attracted to and held in that department? If conditions are not such as to do this now, then they should be changed, and changed quickly. The secret of efficient operation of any department of a railroad is in its men, and no effort or expense is too great that will raise the level of ability and loyalty of the men. If your superior officer does not recognize this, then it is up to you to present facts and arguments to bring him to a full realization of its importance. You dare not sidestep your responsibility in this matter. Car department officers have too long held up their hands and tried to excuse themselves for the conditions which now exist. The importance of the problem is too great to permit of any excuses. Get busy and do your part in making conditions what they should be.

A Weak Spot in Shop Management

Not a few of our railroad shop superintendents and mechanical department officers are due for a severe jolt one of these days. At a time when it is absolutely necessary to use every effort to operate all departments of a railroad efficiently and economically, supervising officers must see to it that no reasonable opportunity is overlooked for making improvement. The introduction of shop schedules has done wonders in a large number of shops in which it has been given a fair trial. We have advocated the use of such schedules for 12 or 15 years and from time to time have explained their application in detail, and have called attention to the concrete benefits which have resulted from their use. For some reason—probably lack of initiative on the part of those in charge—the practice is not by any means general at this late date.

There may be some excuse, although it is doubtful, for the officer who cannot awake to the necessity for introducing modern apprenticeship methods. There is less excuse for the officer who does not realize the value of improving working conditions so that the individual may achieve his highest efficiency. A man to fully appreciate these things must be a real executive and must be able to clearly see into the future. There is, however, absolutely no excuse for the officer who cannot see the concrete and practical value of the shop schedule system. It is not an easy matter to install such a system, but little difficulty is experienced after it is once fully established; in fact it eliminates a great deal of friction and lost motion and greatly simplifies the problem of shop management. A most complete discussion of the details of a successful scheduling system, and its benefits, was presented by Henry Gardner at the 1913 meeting of the International Railway General Foremen's Association (*Railway Age Gazette, Mechanical Edition,* October, 1913, page 423). Briefly such a system will increase the shop output, reduce the unit costs and keep the locomotives out of service a minimum amount of time. The work of the various departments is equalized; friction is reduced; the men know exactly when their work on a given engine must be completed and are better satisfied, whether working on a day work or piece work basis; the foreman's work is simplified and he is able to give more time to the larger problems of his department.

NEW BOOKS

Coal, Its Economical and Smokeless Combustion. By J. F. Cosgrove. Bound in cloth. 273 pages, 5½ in. by 8½ in. Published by the Technical Book Publishing Company, Philadelphia, Pa. Price $3.

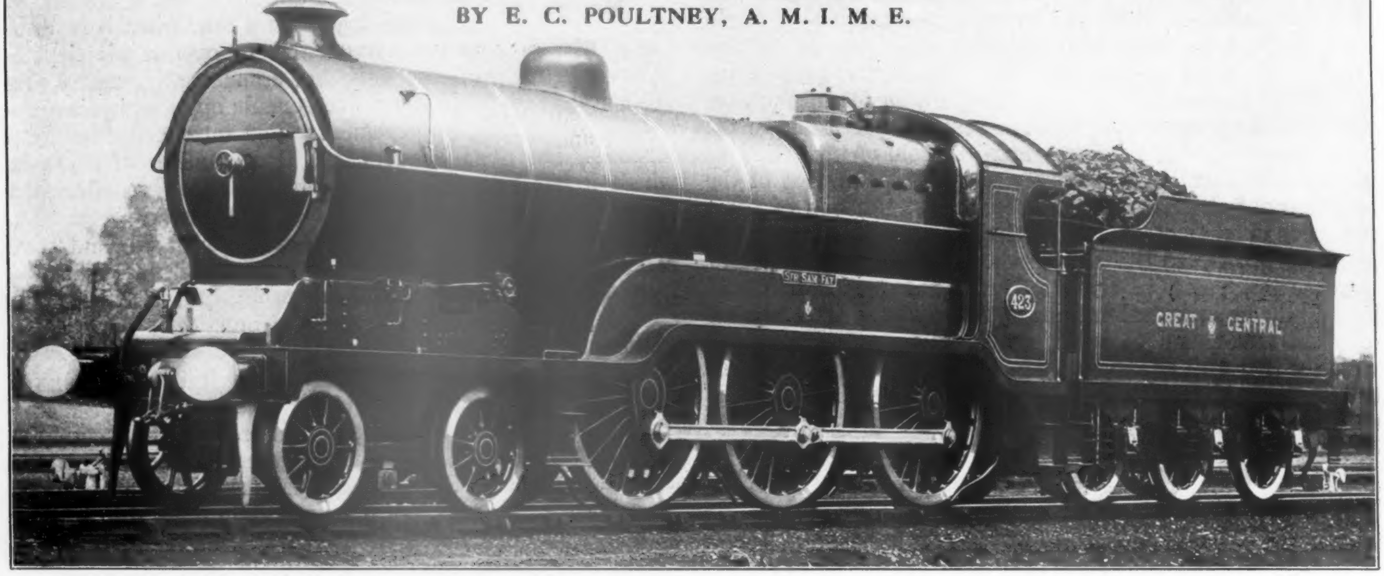
The purpose of the author has been to provide a comprehensive text book on coal for the use of engineers, smoke and fuel inspectors, purchasing agents and all who have to do with the combustion of coal in power plants, locomotives, etc., the entire subject being treated in simple, non-technical language. The book includes in a single volume a large amount of information which, although much of it has previously been available, has been widely scattered and therefore of but little general use. It first takes up the subject of coal, its classification, characteristics and composition, dealing briefly with its geological history and the distribution in the United States. Chapters are also included on the analysis of coal, the determination of its heating value and the purchasing of coal. The remainder of the volume is devoted to various questions relative to combustion, including a discussion of clinkering and its prevention and smokeless firing.

The text is supplemented by over 30 tables and a number of illustrations. In the appendix is given a table showing the analysis of 319 American coals.

BRITISH EXPRESS LOCOMOTIVES

Examples of High Speed Passenger Engines Showing the Tendencies of Modern British Practice

BY E. C. POULTNEY, A. M. I. M. E.



Great Central Six-Coupled, Two-Cylinder Superheater Locomotive

BEFORE entering upon a delineation of some notable examples of express locomotives in use on the principal British railways, which is the purpose of this article, it may be profitable to consider the various types in operation from a comparative standpoint and also to point out the general characteristic features of British locomotive practice.

The table of dimensions and proportions accompanying this article gives the principal types which find favor at the present time, together with the leading dimensions of the engines selected for treatment. By far the most favored engines in use are still the four-coupled type with leading bogie, having, as a rule, inside cylinders; but the reasons which, in the United States, have caused engines with this wheel arrangement to be superseded successively by the Atlantic, six-coupled bogie and Pacific types have, in England, caused designers to turn to these different types. With the exception of the Pacific type, of which there is as yet only one example at work, namely, "The Great Bear" of the Great Western Railway, these types are all to be found in use at the present time. In Britain engines capable of maintaining about 1,500 i.hp. will do all that is required in express service and boilers large enough to produce this power can be carried on ten wheels, hence the Pacific type so largely used in the United States has not passed the experimental stage. The 4-4-2 type naturally received consideration when the general introduction of vestibuled corridor stock increased the demands made on the locomotive, and the first engines of this type with outside cylinders were introduced on the Great Northern Railway for running the Anglo-Scottish expresses. These engines were comparatively small and did not possess boiler power greater than could have been obtained by the use of 4-4-0 engines. However, later much larger engines have been introduced for this service having boilers with 2,500 sq. ft. of heating surface and wide fireboxes giving 30 sq. ft. of grate area.

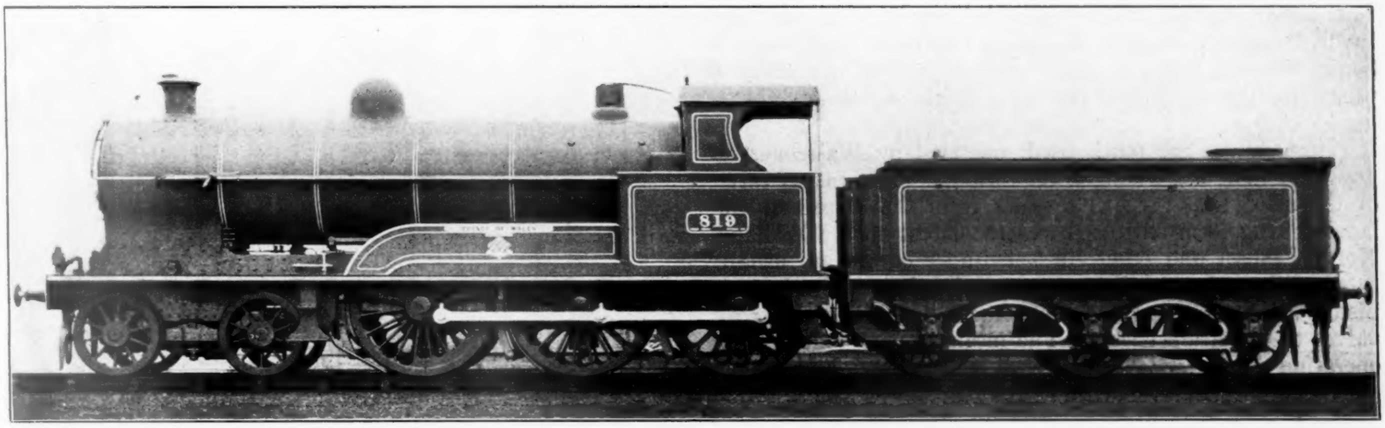
TABLE I—COMPARISON OF EXPRESS LOCOMOTIVE BOILERS, SHOWING ALTERATIONS IN THE HEATING SURFACES AND EVAPORATIVE POWER DUE TO THE INTRODUCTION OF FIRE TUBE SUPERHEATERS

		Heating surfaces				1	2	3
Railway	Type	Tubes	Firebox	Total	Superheater	Reduction in tube surface due to superheater, per cent	Reduction in evaporative power of boiler, per cent	Superheating surface, per cent of tube surface
Caledonian	4-6-0	2,111.75	148.25	2,260				
		1,666.0	148.25	1,818.25	515	21.0	14.2	23.7
London & North Western	4-6-0	1,857	133.00	1,990.00				
		1,439.59	133.33	1,572.92	324.58	22.5	11.05	18.4
Great Western	4-6-0	1,989	154.0	2,143.0				
		1,687	154.8	2,241	330	15.2	9.84	16.4
London & North Western	4-4-0	1,800.25	161.75	1,962.0				
		1,385.0	161.75	1,547	302.5	28.6	10.75	17.9
North Eastern	4-4-2	2,160	180	2,340				
		1,798.9	180	1,979	530	16.7	13.62	22.7
Great Northern	4-4-2	2,359	141	2,500				
		1,884	143	2,027	570	20.5	13.92	23.2
Midland, compound (superheated)	4-4-0	1,305.5	152.8	1,458.3				
		1,170.0	151.0	1,321.0	360	10.3	14.12	23.5

Note: The above particulars are taken from boilers which have been rebuilt with superheaters of the Schmidt type for high degree superheat, except in the case of the Great Western, which, as will be seen, uses smaller superheaters, due to the fact that the practice on this railway is to use a low degree of superheat.

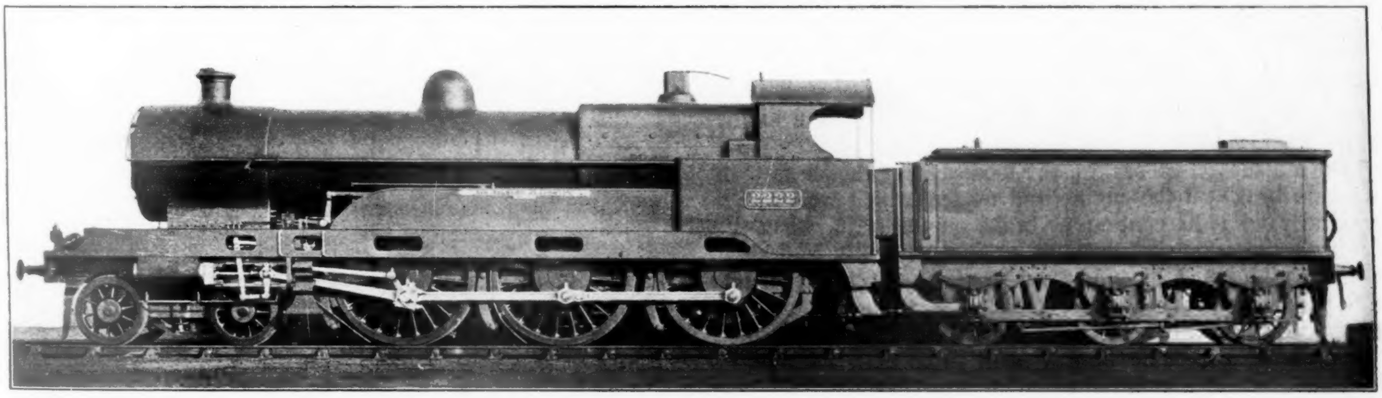
The North Eastern Railway, under the direction of the late chief mechanical engineer, W. Worsdell, was the first railway to introduce six-coupled locomotives for express service; here again the first engines were comparatively small, but

later engines were given larger boilers and the driving wheels were increased in size from 73 in. to 80 in. diameter. In both classes the cylinders were placed outside the frames and drove on the second coupled axle. These engines have now, however, given place to large 4-4-2 engines, the first of which type were, at the time of their introduction, among the largest engines in Britain, having outside cylinders 20 in. in diameter with a stroke of 28 in., boilers with approximately 2,500 sq. ft. of heating surface and weighing without tender 73 tons. More recently these engines have been superseded by some of the same type but having three cylinders and fitted with Schmidt superheaters.



Six-Coupled, Two-Cylinder, Superheater Locomotive, London & North Western

The Caledonian Railway was the first to introduce 4-6-0 engines of the largest class. They were designed by J. F. McIntosh to conduct the heavy West Coast Dining Car trains over that road between Carlisle and Glasgow and had, when first built, 21-in. cylinders—the largest ever used in express service at that time. The cylinders were inside the frames and the leading axle was the crank axle. The cylinders subsequently were reduced to 20 in. in diameter and more recently further engines of this type were built having 20-in. cylinders and some detail modifications, such as the substitution of direct stays for staying the firebox crown instead of roof bars, and some alteration in the size of the motion bearing surfaces. Now all have been rebuilt with Schmidt superheaters and fitted with 20½-in. cylinders having piston valves, the steam pressure being 180 lb. against 200 lb. originally used.



Six-Coupled, Four Cylinder, Superheater Locomotive, London & North Western

From what has been said of the six-coupled design, it will be seen that some designers favor inside cylinders and others use outside cylinders and connections; with the exception of the Caledonian and the London & North Western, however, nearly all the six-coupled express engines in use have outside cylinders. No doubt, the long connecting rods obtained, together with the direct thrust on the coupling rods and the unrestricted length of axle bearings due to the use of straight axles are points in favor of this arrangement. On the other hand, inside cylinders provide a more steady running engine and enable lighter counterbalance weights to be used, due to the closeness of the cylinder centers, and it is interesting to point out that the Great Central, after having used six-coupled engines with outside cylinders, has adopted the inside cylinder design in its most recent construction. Four cylinders as a compromise between the two have lately received attention, and the London & North Western and the Great Western, especially the latter, have large numbers of four cylinder simple superheater engines at work giving fine results.

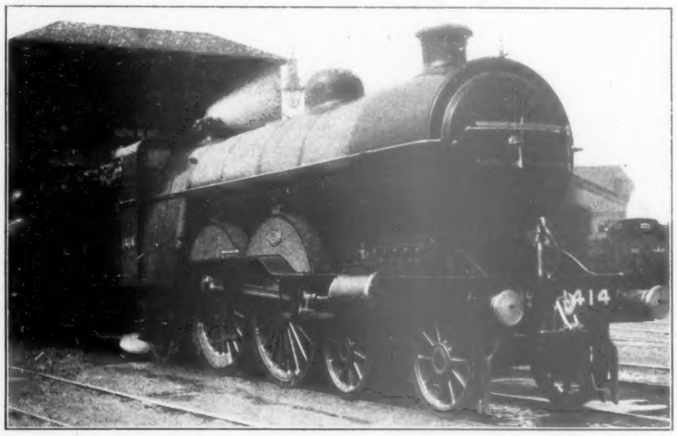
When considering cylinders, it is natural to turn to the question of compounding, which in England has been in the past a much debated point. The late F. W. Webb of Crewe for many years upheld the use of compound cylinders, more particularly his own three cylinder system as exemplified in his "Greater Britain" or "Queen Empress" type and latterly by the four cylinder "Jubilee" type. At the present time the only compounds of note are those running on the Midland Railway and known as the Smith three cylinder system, the arrangement comprising the use of one high pressure cylinder exhausting into two low pressure cylinders, which is exactly the reverse of the Webb system.*

Other features of British practice are the universal use of plate frames and of round topped outside fireboxes, though this latter feature is not so universal now as a few years ago. Direct roof stays are being used much more than formerly, as they make for a better circulation over the crown sheet of the firebox. Some designers use direct stays entirely, those

*There are three De Glehn compound engines in express service on the Great Western Railway.

at the tube sheet end arranged to permit of the upward expansion of the firebox, and others use a few roof bars running transversely across the firebox at the tube sheet end in order to allow for upward expansion, the rest of the load being taken by direct stays. Owing to the increased size of boiler barrels, together with the use of narrow fireboxes, the back sheet of the outside firebox is sometimes dished inwards. This facilitates the removal of the inside box for repairs and at the same time makes it easy to close the rivets holding the back plate by hydraulic pressure. Due to the greater steaming capacity of modern boilers, it is now common to provide four safety valves. Water tubes of any kind do not find favor, though at one time this was a feature of the London & South Western engines, these engines having two nests of tubes running across the firebox. Brick arches are always used.

Piston valves are much used, operated by Walschaert or Joy valve motion. Owing to the introduction of piston valves of the solid ring type as distinct from the segmental collapsible ring form still used to some extent on the Midland, North Eastern and other lines, cylinder covers are usually fitted with spring loaded water relief valves and whenever piston valves are used, it is the practice to fit automatic air valves to the steam chests. The means usually adopted for operating the reversing gear is a wheel and screw. Some railways, however, use a steam gear consisting of a small steam cylinder and a water cylinder for holding the gear in the desired position.



Great Northern Two-Cylinder, Atlantic Type Locomotive

On the subject of brakes, the most usual practice is to fit a steam brake on the engine and tender, which works automatically with the continuous brake on the train, when this brake is the automatic vacuum, or independently if desired. Some modifications have now, however, taken place regarding this practice and the London & North Western now use only the vacuum brake which operates on the engine and tender.

The most noticeable improvement in modern locomotives is, undoubtedly, the introduction of superheaters. All new express locomotives are so fitted and many older engines have been rebuilt with superheaters and larger cylinders, the latter feature being necessary if the full value of the superheater is to be realized. The introduction of fire tube superheaters causes some modification in the heating surfaces and Table I shows particulars of the heating surface of boilers before and after being fitted with superheaters. The figures obtained in column 2 are obtained by assuming that 60 per cent of the evaporative power of the boilers is in the tube heating surface.

When superheaters were first introduced, damper gear was always considered necessary to protect the elements from becoming overheated when the regulator is closed, and while a number of railways still use dampers, either worked by hand or automatically, others have dispensed with them altogether.

TABLE II—DIMENSIONS AND PROPORTIONS OF MODERN BRITISH EXPRESS LOCOMOTIVES

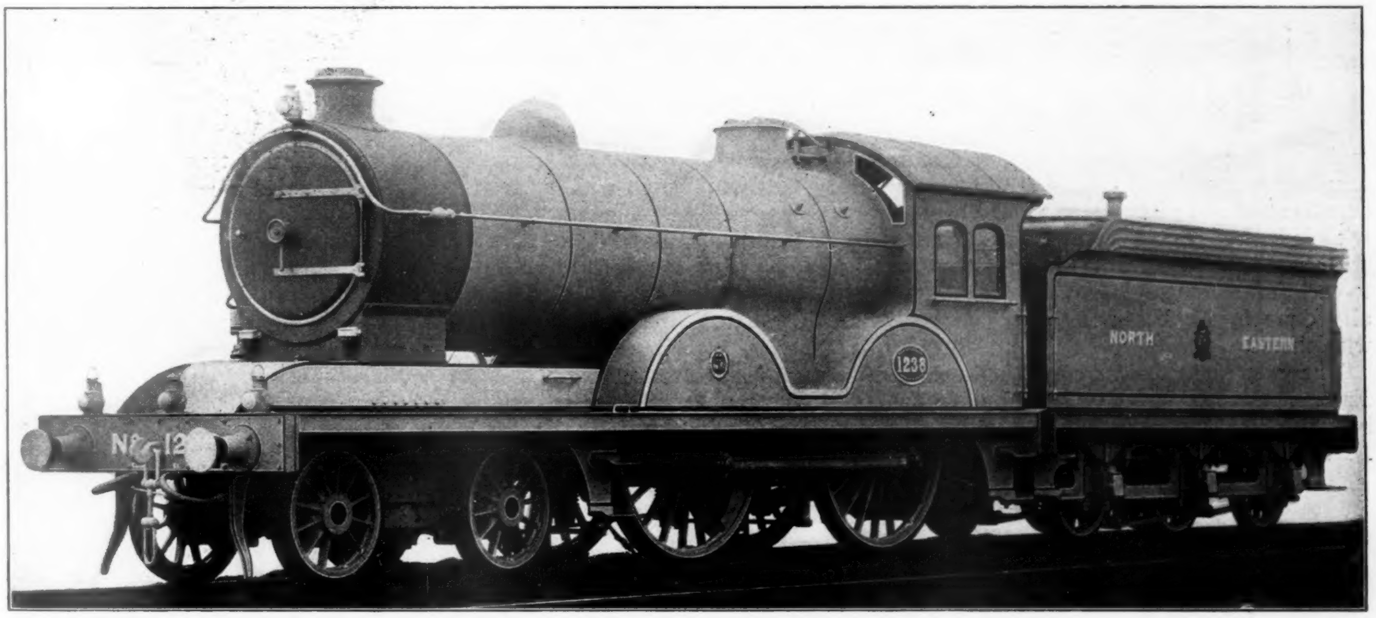
Railway	London & North Western		Great Central	Great Northern	North Eastern		Great Western		Midland	Lancashire & Yorkshire
Type	4-6-0	4-6-0	4-6-0	4-4-2	4-4-0	4-4-2	4-6-0	4-6-0	4-4-0	4-6-0
Cylinders, number	2	4	2	2	2	3	2	4	3	4
Cylinders, size	20½ in. by 26 in.	16 in. by 26 in.	21½ in. by 26 in.	20 in. by 24 in.	19 in. by 26 in.	16½ in. by 26 in.	18½ in. by 30 in.	15 in. by 26 in.	1 H.P.—19 in. by 26 in. 2 L. P.—21 in. by 26 in.	16 in. by 26 in.
Coupled wheels, diameter	6 ft. 3 in.	6 ft. 9 in.	6 ft. 9 in.	6 ft. 8 in.	6 ft. 10 in.	6 ft. 8 in.	6 ft. 8½ in.	6 ft. 8½ in.	7 ft.	6 ft. 3 in.
Boiler pressure, lb. per sq. in.	175	175	180	170	225	160	225	225	220	180
Heating surface, tubes, sq. ft.	1,439.59	1,647.2	2,219.0	1,884.0	1,579.0	1,798.9	1,599.0	1,687.0	1,305.5	2,317.0
Heating surface, firebox, sq. ft.	133.33	171.2	167.0	143.0	158.0	180.0	155.0	154.0	152.8	190.0
Heating surface, total, sq. ft.	1,572.92	1,818.4	2,386.0	2,027.0	1,737.0	1,978.9	1,754.0	1,841.0	1,458.3	2,507.0
Superheater heating surface, sq. ft.	324.58	413.6	440.0	570.0	....	530.0	287.0	330.0	....	....
Total equivalent* heating surface, sq. ft.	2,059.5	2,438.0	3,046.0	2,872.0	....	2,773.9	2,184.0	2,336.0	....	....
Grate area, sq. ft.	25.0	30.5	26.0	31.0	27.0	27.0	27.0	27.0	28.4	27.0
Tractive effort, lb.†	21,000	24,300	22,750	17,340	21,891	17,900	24,300	27,934	....	26,862
Cylinder, volume per mile, cu. ft.	5,340	6,025	5,400	4,430	4,196	4,948	4,635	5,363	7,056	6,580
Weight on coupled axles, lb.	104,720	132,160	126,560	80,520	93,280	88,704	129,750	124,096	87,360	131,200
Weight of engine only in working trim, lb.	148,512	174,250	168,560	156,256	132,160	171,808	161,280	169,344	134,952	172,648
Superheating surface, per cent of the total heating surface	17.0	18.5	15.5	21.9	....	21.0	14.0	15.2	....	....
Cylinder volume per mile ÷ heating surface (actual)‡	....	....	....	....	2.34	....	....	....	4.83	2.62
Cylinder volume per mile ÷ equivalent heating surface	2.54	2.49	1.77	1.54	....	1.80	2.12	2.30	....	....
Cylinder volume per mile ÷ grate area	213.6	197.5	208	142	155.4	183.0	167.9	198.9	248.0	243.7
Weight on coupled axles ÷ tractive effort	5.0	5.4	5.57	4.64	4.21	4.94	5.38	4.47	....	4.5
Total engine weight ÷ heating surface (actual)‡	78.0	78.0	59.5	60.16	76.0	68.4	78.9	77.8	92.5	68.0
Total engine weight ÷ equivalent heating surface	72.1	70.2	55.0	54.4	....	61.5	73.8	72.4	....	....
Weight on coupled axles, per cent of the total engine weight	70.0	75.9	75.2	51.5	70.6	52.4	80.2	73.4	64.7	76.0

* Equivalent heating surface = total evaporative heating surface + 1.5 times the superheating surface. † Mean effective pressure 85 per cent of boiler pressure.
‡ Actual heating surface = total evaporative heating surface + the superheating surface.

An example of the latter is to be found in the Great Central practice. This company's engines are fitted with an arrangement of steam jets which come into action when the steam blower is in use, and are arranged to set up a counter draught down the large flues containing the elements, in that way protecting them from becoming overheated. The superheater engines on the Great Northern have a large air valve fitted to the superheater header. This valve opens when the regulator is closed and admits air into the elements comprising the superheater, thus preventing them from becoming overheated when there is no steam passing through. The valve is placed on the smokebox behind the stack, and is not shown in the photograph, as the engine illustrated works with saturated steam; otherwise in appearance the superheated and saturated engines are alike. Another method adopted to keep the elements from getting overheated is to arrange a supplementary supply of steam to be automatically supplied to the elements; when the main supply of steam to the cylinders is shut off the supplementary steam is circulated through the superheater and then through the cylinders and valve chests. It thus acts as a lubricating medium when the engine is running with the regulator closed, and when the engine is standing serves to keep the cylinders warm. This arrangement is used by the North Eastern Railway in place of dampers. The practice on the London & North Western is to use dampers, the opening and closing of which is done by hand, a lever being fitted in the cab on the driver's side for this purpose. The Great Western engines have dampers which open and close automatically with the opening and shutting of the throttle, a small steam cylinder being fitted for operating them.

The engines selected for descriptive purposes are representative of modern construction and are, with the exception of the Midland compound, the North Eastern 4-4-0 and the Lancashire & Yorkshire 4-6-0 engines, all fitted with fire tube superheaters. The London & North Western engines illustrated have been introduced to handle important main line trains, and the inside cylinder class is really similar in design to engines introduced in 1906 to work on the northern section of the line which runs over the Westmoreland mountains. This engine is fitted with a Schmidt superheater and inside admission piston valves operated by Joy valve motion through the medium of rockers. The Joy valve gear is the standard on all modern two cylinder engines in use on the London & North Western; the space between the crank webs which would otherwise be used by the eccentrics of the Stephenson gear is utilized by a central bearing, carried by a steel casting bolted to the frame stretcher in front of the firebox and to the motion plate carrying the guide bars. The crank axle is built up and the crank webs are extended to form balance weights.

The most modern express engines built have four cylinders and one of the photographs shows the latest type of engine designed for the heaviest express service on the London & North Western. The four cylinders are placed in line across the front of the engine and all drive on the front coupled axle. The inside cranks are placed at 180 deg. to the outside cranks on the same side of the engine so that they travel in opposite directions, which enables one set of valve gears, in this case Walschaert, to be used to operate the two valves. The valves are of the cylindrical type giving inside admission. This arrangement is effected by fitting the valve gear to the outside motion and extending the valve stems through the front covers of the steam chests, connection here being made to horizontal vibrating levers of the first order, which in turn are coupled to the inside cylinder valve spindles. Each pair of cranks are at 90 deg. to each other. The crank axle is built up and has a central bearing. The boiler is large, having a superheater and a Belpaire firebox with 31 sq. ft. of grate area. These engines, of which several are now at work, can maintain 1,400 i.hp. and are the heaviest express locomotives in the country, weighing without tender 78 tons in working trim. The automatic vacuum brake operates on the engine and tender.



North Eastern Four-Coupled, Two-Cylinder Locomotive

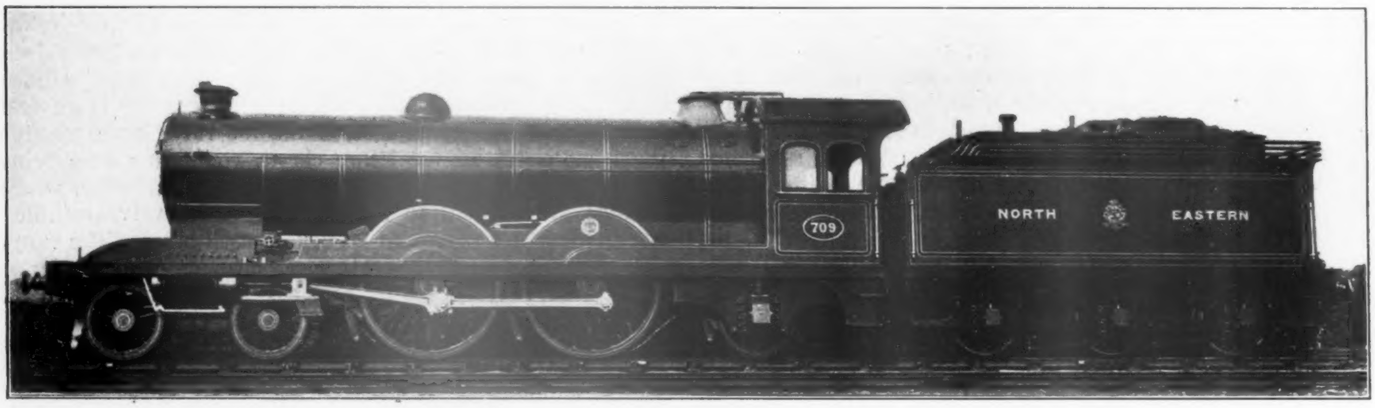
The Great Central Railway use the type of engine shown to conduct their heaviest traffic. The engines are the largest of their type in use, and are noteworthy from the fact that they have boilers containing more heating surface than any other express engines in Great Britain and show what can be accomplished within the restrictions imposed by the British running dimension outline. These engines have two cylinders $21\frac{1}{2}$ in. in diameter by 26 in. stroke. Piston valves are placed above the cylinders and are worked by the ordinary link motion through rockers. The piston rods are extended to pass through the front cylinder covers, a practice now quite general since the introduction of superheated steam. Exceptions are, however, to be noted in the case of the London & North Western and Great Western four cylinder engines and the North Western three cylinder engines. In these instances necessity for this detail does not arise, owing

to the fact that the pistons are of much smaller diameter. The use of piston valves is also almost invariable with superheated steam and both valves and pistons are oiled by forced feed lubrication.

The Great Northern uses the engine illustrated for heavy fast traffic between London (Kings Cross) and York. This engine has already been briefly mentioned, and is remarkable for its boiler capacity and its wide firebox, the latter feature a novelty in British practice. The cylinders are 20 in. in diameter with a piston stroke of 24 in., which is shorter than is usually employed. In order to further reduce the centrifugal force set up by the coupling rods, the main crank pins are turned eccentric and the throw of the coupling rods reduced to 22 in. The engines are fitted with superheaters and piston valves. The bogie axles are equipped with independent coil springs, two to each journal instead of the usual long inverted leaf spring, transmitting its elasticity to each journal by means of a compensating beam, as is usually done in English practice. The bogies are also fitted with the American swinging link arrangement.

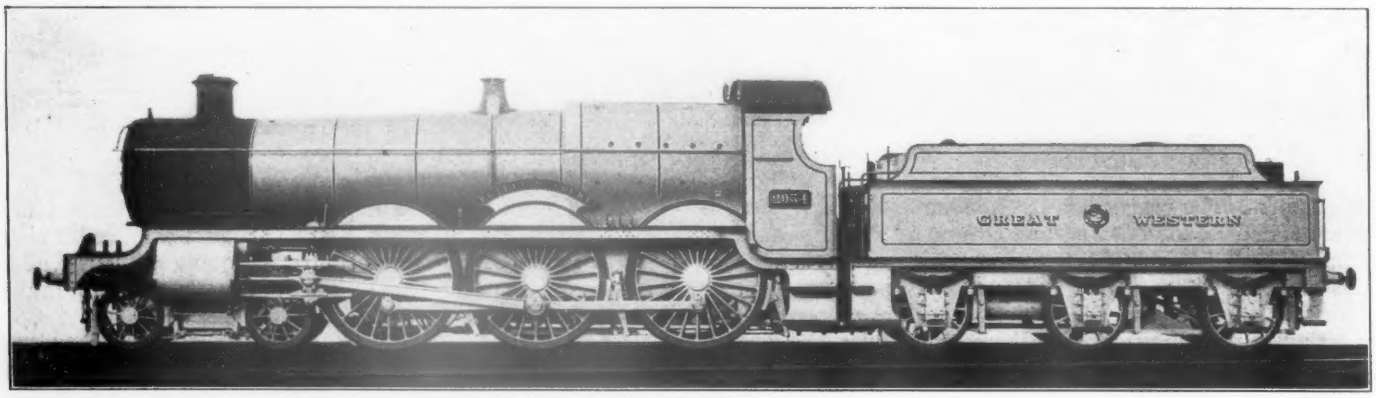
The next engines to be considered are in use on the North Eastern which forms the middle link in the East Coast route between London (Kings Cross) and Scotland. The North Eastern provides the power for running the joint stock trains between York and Berwick, and it is upon this service that the two engines illustrated are utilized. The four-coupled engine was introduced some few years ago by W. Worsdell, and indicates an engine which reaches dimensions approaching the maximum possible with this wheel arrangement. The cylinders placed between the frames are arranged with their axis inclined slightly upwards and the piston valves are on the top of the cylinders placed with their center line inclined downwards to the center of the crank axle; thus the valves can be worked direct by the valve motion which in this case is the ordinary Stephenson gear, without the intervention of rockers. Several of these engines have been fitted with superheaters.

Four-coupled bogie engines of similar general dimensions to those just noticed are to be found on the London & North Western, the Great Central* and the South Eastern & Chatham, and it can safely be said that where a maximum of 2,000 sq. ft. of heating surface will provide the power required this type of engine has many advantages. Such engines on the London & North Western equipped with superheaters have demonstrated their ability to maintain 1,100 i.hp. Naturally, the size of engine that can be used having the 4-4-0 wheel arrangement depends on the allowable weights. In England, engines of this type weigh about 60 tons and carry 39 tons on the coupled axles.



North Eastern Three-Cylinder, Atlantic Type Locomotive

The North Eastern 4-4-2 type engine illustrated is perhaps one of the most interesting of modern express locomotives. It is representative of a class designed by V. L. Raven, the present chief mechanical engineer, to deal with the most important traffic. It has three cylinders placed in line across the front of the engine, driving on the leading coupled axle with cranks at 120 deg. They are cast together in one piece, together with their valve chests. The valve chests for the outside cylinders are at the side of their respective cylinders and the center cylinder has its valve chest on the top. Piston valves are used, operated direct by the ordinary double eccentric valve motion, the whole arrangement being particularly neat and calling for some clever designing. The single throw crank axle has circular crank webs common to all North Eastern engines. This enables the crank axles to be finished entirely in the lathe. In accordance with standard North Eastern practice, they are fitted with the Westinghouse brake.

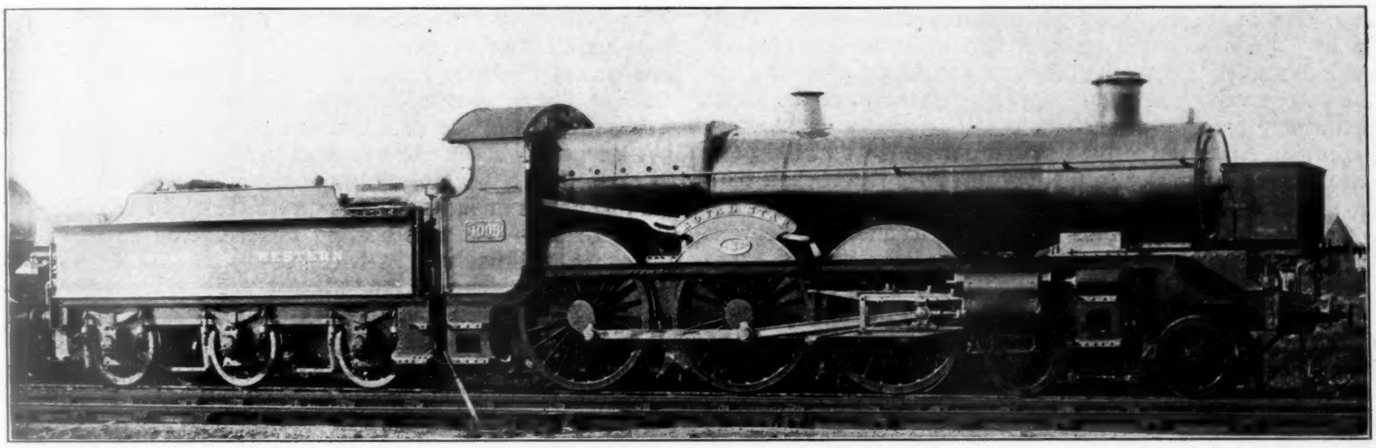


Great Western Six-Coupled, Two-Cylinder, Superheater Locomotive

The most important express traffic on the Great Western is conducted by locomotives of the types illustrated. One has

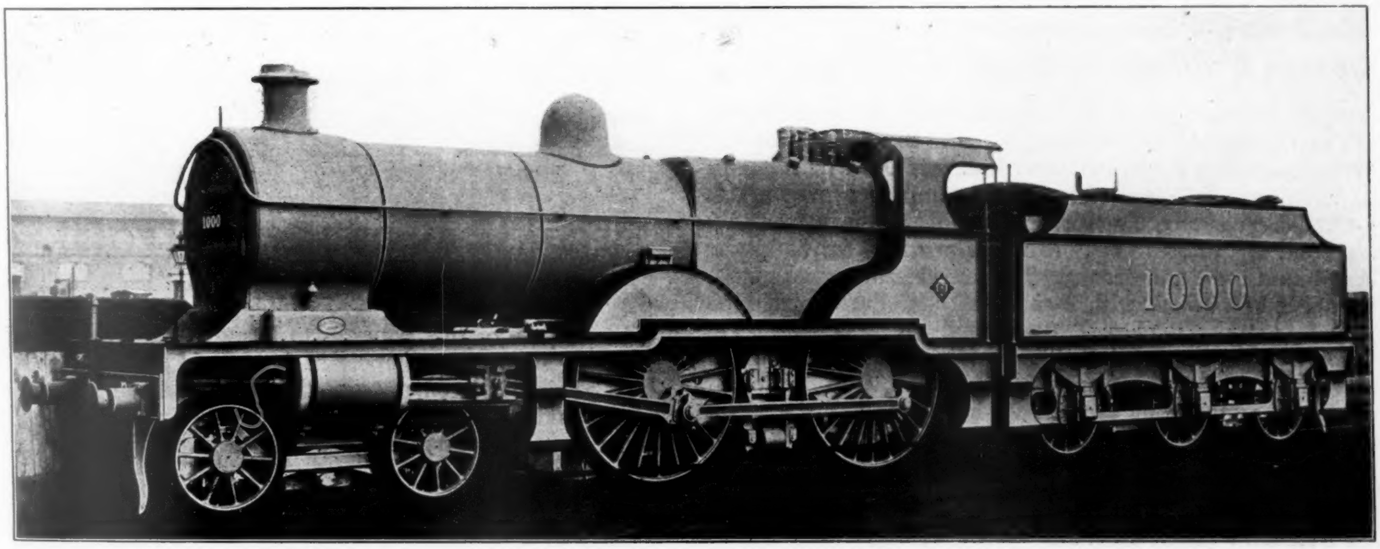
*For a description of the Great Central 4-4-0 engines, see *Railway Mechanical Engineer* for August, 1916.

two outside cylinders which are remarkable for the long stroke of the pistons, namely, 30 in., and the other is a four cylinder engine having two cylinders inside arranged to drive on the leading coupled axle. The outside, as will be seen, drive on the second axle; in that way the strains are divided. The arrangement of the cranks is exactly similar to the four cylinder engines of the London & North Western already considered; but in this case Walschaert valve gear is applied to the inside motion, the valves for the outside cylinders being driven by rocking levers in the same way as in the placed on the safety valve mounting. The water is then distributed by means of trays in the boiler barrel. In this way boiler strains due to local contraction caused by this introduction of cold feed water in close proximity to the boiler plates is eliminated. It will be noticed that the Great Western engines are without steam domes, the steam supply to the cylinders being obtained through a pipe running through the steam space in the barrel of the boiler to a point over the firebox crown sheet, the regulator valve being placed in the smokebox. The continuous brake used on the Great West-



Great Western Six-Coupled, Four-Cylinder Superheater Locomotive

London & North Western engine except that in this case the rockers are driven from the main valve spindle for the inside valves instead of by extensions through the front covers of the valve chests. This is necessary owing to the position of the outside cylinders. Great Western practice in boiler design differs somewhat from ordinary British practice, and the boilers of these engines are the outcome of careful experimenting.* A Belpaire firebox is used, together with a ern is the automatic vacuum and an air pump driven from one of the cross heads is used to maintain the vacuum in the train pipe and reservoirs when running, in place of the small ejector generally employed. This method is also used on the London & North Western and the North Staffordshire Railways.† Fire tube superheaters are fitted and the steam pressure employed is 225 lb., which is unusually high, especially in the case of superheater engines. Both pull trains



Four-Coupled, Three-Cylinder Compound Locomotive, Midland Railway

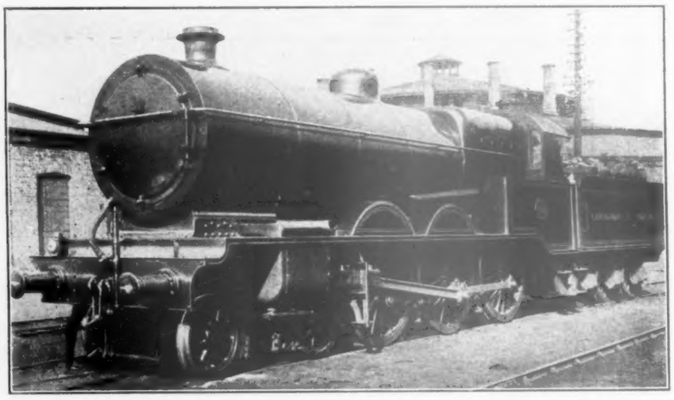
long tapered barrel, the general idea being to get as much water as possible at the hottest part of the boiler and at the same time to increase the water line area where most steam is generated. The bogie wheels are fitted with brake blocks, contrary to ordinary English practice. Another distinguishing feature of Great Western practice is the method adopted in supplying the feed water to the boilers. This is fed into boiler steam space by means of pipes leading to check valves of over 400 tons at 60 miles per hour over the main line.

The Midland engine shown is a three-cylinder compound with cylinders arranged on what is known as the Smith system. One high pressure cylinder is placed between the frames with connection to the leading coupled axle through a single throw crank axle, and the two low pressure cylinders are placed one on each side of the engine, connecting, as

*See paper on "Large Locomotive Boilers" by G. J. Churchward, Proceedings Institute Mechanical Engineers, 1906.

†The most recent locomotives on the North Staffordshire Railway are equipped with combination ejectors of the Gresham and Craven type and the use of air pumps is discontinued.

shown, to the leading coupled wheels. The regulator valve in the dome has an additional jockey valve, the arrangement being such that on the first movement of the handle controlling the regulator the jockey valve only is opened. The jockey valve opens a port connected to a small pipe, which conveys steam direct from the boiler to the low pressure steam chests. Connecting both ends of the high pressure cylinder with one of the low pressure steam chests are two pipes fitted with spring loaded non-return valves, which open when the pressure in the low pressure steam chest is greater than the pressure in the high pressure cylinder. It follows then that in starting the high pressure piston simply floats in its cylinder and the train is started by the low pressure cylinders only. On further movement of the regulator handle the jockey valve closes the supply of steam from the boiler to the low pressure steam chests and opens the main valve supplying steam to the high pressure cylinder, and the pressure now being greater in the high pressure steam chest than in the low pressure steam chest, the non-return valves are forced to their seats, thus cutting off connection between the high pressure and low pressure cylinders, except through the high pressure exhaust, the engine, therefore, commencing to work compound. Steam is distributed in the high pressure cylinder by a piston valve placed below the cylinder, and as it has its axis inclined upward to the center of the crank



Lancashire & Yorkshire Four-Cylinder, Six-Coupled Locomotive

axle it is driven direct without the intervention of rockers. Ordinary unbalanced flat valves are used for the low pressure cylinders, driven by the ordinary link motion. The reversing gear consists of a wheel and screw, the high and low pressure gears being operated together. Independent adjustment of the high and low pressure motions is not provided for, it having been found to be unnecessary. The low pressure cranks make an angle of 90 deg. with each other, and the central high pressure crank is placed at an angle of 135 deg. with the low pressure cranks. The driving wheels are 7 ft. in diameter and the high pressure cylinder is 19 in. by 26 in., the low pressure being each 21 in. by 26 in., and the steam pressure 220 lb. Engines of this type have been run in competition with engines of similar general dimensions having two simple cylinders, and their designer, R. M. Dealey, writing in The Engineer of December 17, 1909, stated that the compound engine consumed .129 lb. of coal per ton-mile against .139 lb. consumed by the simple engine. It must, however, be pointed out that the simple engine worked with a boiler pressure of 180 lb. as against 220 lb. carried by the compound. There are 40 of these engines in service, and latterly some have been superheated with excellent results.

The Lancashire & Yorkshire utilizes the large type of six-coupled engine illustrated to work the heaviest express trains over the main line between York, Manchester and Liverpool. The engines were also designed with a view of being able to haul important fast goods traffic. The coupled wheels are 75 in. in diameter and there are four cylinders, each 16 in. diameter, with a piston stroke of 26 in. The arrangement of the cranks is exactly the same as in the Great Western four-cylinder engine described, and in order to obtain sufficient length for the inside connecting rods the inside cylinders are placed well forward under the smokebox. The Joy valve motion, which has been the standard for many years on the Lancashire & Yorkshire, is used and is applied to the inside running gear. The engines are not superheated, but, as will be seen with the above dimensions, together with a boiler having 2,507 sq. ft. of heating surface and working at 180 lb. steam pressure, are very powerful locomotives. They were very fully described in a paper read before the Institute of Mechanical Engineers by G. Hughes, the chief mechanical engineer of the Lancashire & Yorkshire, in 1909. Besides this particular class of engine the Lancashire & Yorkshire has in use a number of powerful engines of the 4-4-2 type, having inside cylinders and coupled wheels 87 in. in diameter. When first introduced, these engines possessed the distinction of having the largest boilers of any engine in Great Britain—the total heating surface being 2,050 sq. ft.

From the illustrations it will be seen that the six-wheeled tender is the most usual type, though the Midland, Caledonian and London & South Western use the double bogie type to a limited extent. The large 4-6-0 engines on the Caledonian have double bogie tenders on account of the large size of the engines and the absence of track troughs. In general, the use of water troughs and superheaters makes tenders having a greater capacity than 5 tons of coal and from 3,000 to 4,000 gallons of water unnecessary.

The table of dimensions and proportions shows the chief characteristics of British practice. The cylinder volume swept through per mile in cubic feet has been calculated and compared with the heating surfaces and grate areas, thus giving an idea of the steam using capacity of the engine compared with steam producing power of the boilers, and the figures relating to the heating surface and engine weight and those comparing the total weight and adhesive weight give information, the importance of which need not be insisted on here. Weights expressed in tons and capacities in gallons in the text of this article are all English measure.

In an article of this kind it is impossible to describe more than a limited number of engines, but those mentioned are representative of recent construction and are believed by the writer to show the modern tendency in the design of British express locomotives. The photographs here reproduced are all by F. Moore, Finsbury Circus, London, E. C.

MECHANICAL DESIGN OF ELECTRIC LOCOMOTIVES*

BY A. F. BATCHELDER

The purpose of this paper is to bring to the attention of the Society some of the important features in the mechanical design of electric locomotives, with a view of having a more common understanding of the requirements and the method of meeting them. These features may be listed in the order of their importance as follows:

1—Safety of operation
2—Adaptability to sedvice conditions
3—Reliabiilty in service
4—Convenience of arrangement as affecting safety and efficiency of operation
5—Power efficiency (affected by mechanical design)
6—Service time factor (ratio, time available for service to total time)
7—Cost maintenance of permanent way
8—Cost maintenance of locomotives
9—First cost.

SAFETY OF OPERATION

The steam locomotive has been developed by degrees to such a state of perfection that it is common to see it operate at near 80 m. p. h. and with perfect safety; but no one

*A paper which will be presented and discussed at the Railroad Section of the annual meeting of the American Society of Mechanical Engineers, held December 8, 1916, in New York.

would think of operating at this speed backwards. With the coming of the electric locomotive, the railroad operator is not content with single end operation, but must have a locomotive that will operate equally well in either direction. This does not impose any serious difficulties in the design of locomotives which operate at speeds under 50 m. p. h., but with locomotives for the higher speeds it presents new problems or at least it requires the most careful consideration of the running gear details, to obtain the most satisfactory results as to tracking and the effect on the rails and road bed.

The steam locomotive has what now seems to be natural characteristics to allow high speed operation in one direction. These characteristics are low center of gravity at the front end carried on the center pin of a two axle guiding truck tending to prevent rolling over and having but little effect on the guiding, and high center of gravity on the rear end with inside journal bearings allowing the locomotive to roll and increasing the time element, which thus reduces and distributes the lateral pressure against the rail over a longer distance. This increases the vertical pressure on the rail, thus holding it more firmly in place. These same characteristics can be obtained in electric locomotives by the sacrifice of double end operation.

The advantages gained in operating the electric locomotive in either direction are so important that means should be provided for satisfactory double end operation. One way of doing this is by using a four wheel guiding truck at each end of the locomotive. With the use of the extra truck, however, the importance of a high center of gravity largely disappears. The lateral pressure against the rail at the rear end now appears at the truck flanges rather than at the flanges of the driving wheels and the high center of gravity no longer provides the same increased vertical pressure on the outer rail at the point of the maximum lateral pressure. The lateral stresses from guiding the main frame being taken at the center pin of the two guiding trucks, the additional vertical pressure on the outer rail is dependent upon the height of these center pins rather than upon the height of the center of gravity of the main frame above the wheel hubs, thus leaving less advantage to be derived from a high center of gravity.

To demonstrate more clearly, it is well to see what happens to a locomotive when entering a curve, which is also illustrative of its action on tangent track when oscillating from one side to the other. A locomotive having a high center of gravity and with two driving axles guided by a two-axle swivel truck will serve to illustrate the action. As the locomotive enters the curve, its tendency is to continue on in a straight line but the flange of the leading wheel gradually comes in contact with the outer rail, giving the guiding truck an angular motion about its outer rear wheel and exerting a lateral pressure against the center pin, thus giving the main frame an angular motion around its outer rear wheel.

The lateral pressure tending to displace the rail at the leading wheel is the amount required to slip the two inner wheels, and to accelerate the truck around its outer rear wheel, plus one-half the amount required to slip the two leading drivers and the rear inner driver, and to accelerate the main frame around its rear driving wheel, plus its relative portion of the centrifugal force of the whole locomotive. The lateral pressure tending to displace the outer rail at the rear wheel of the leading truck is the amount of reaction from slipping the two inner wheels and the angular acceleration of the truck plus one-half of the amount required to slip the two leading drivers and the rear inner driver and to accelerate the main frame around its rear outer driving wheel, plus its relative portion of the centrifugal force of the whole locomotive.

The lateral pressure tending to displace the outer rail at the rear wheel of the main frame is the amount of reaction from slipping the two leading drivers, the inner rear driver and the angular acceleration of the main frame plus its relative portion of the centrifugal force of the whole locomotive. The greater weight being concentrated at the drivers, and the distance of the truck center pin from the main truck wheels being greater, and the fact that there is but one wheel to take the strain, it follows that the point of the greatest concentrated lateral pressure is at the rear outer driving wheel.

The above disregards the important factor of time, in the accelerating and centrifugal forces due to the rolling, governed by the height of the center of gravity above the wheel hubs, which tends to reduce the lateral pressure at the rear outer driving wheel. With a high center of gravity above the wheel tread the accelerating and centrifugal forces also tend to tip the locomotive up on the outer driving wheels, relieving the weight from the inner wheels and thus lessening the force required to slip them, at the same time increasing the adhesion between the outer rail and tie by the additional weight. On good road bed and rails the locomotive described is capable of being run at above 80 m. p. h. without any apparent bad effect on the track.

If this locomotive is operated in the opposite direction, the lateral stresses at these wheels are of the reverse order, the guiding force now being applied at the driving wheel flanges and the reaction taken through the center pin to the truck wheel flanges. The swivel truck, now trailing, is free to oscillate from one side to the other, and the reaction from the force of turning the main frame may be applied at the center pin when the truck wheel flanges are tight against the inner rail. The force is thus allowed to accelerate the truck as well as the main frame through the gage clearance to the outer rail, thus adding momentum, the value of which depends upon the lateral distance through which the truck is moved. As the vertical pressure on the rail is limited to the normal weight at the wheels plus the vertical component of the force applied only at the height of the center pin of the truck, the relative lateral to the vertical pressure at the wheels of the truck may be greatly increased. A number of observations have appeared to confirm the fact that the action of the trailing truck above described is one of the most important in producing excessive lateral pressures against the rail in a symmetrically built electric locomotive with similar trucks at both ends. It will be seen therefore that while the swivel truck is desirable as a guiding agent at the front end, it is not as desirable at the rear end, and means must be provided to prevent oscillation of the truck and to accomplish the same results as the high center of gravity in a single end locomotive.

To accomplish these results, it is necessary to reduce the momentum effect and to reproduce the equivalent of the time element factor and of the increase of vertical pressure on the outer rail that is characteristic of the high center of gravity single end locomotive.

The momentum effect can be reduced by introducing resistance against swivelling, thus restricting the truck from oscillating from one side of the track to the other, the amount of this resistance to be determined by the allowable amount that can safely be applied to the truck when leading. To reproduce the time element factor, lateral movement can be given to the truck center pin by any of the several methods for giving lateral movement to the leading truck center pins on locomotives. However, the writer has obtained the best results with the method that is the nearest to constant pressure and dead beat, as it also tends to prevent oscillating. To increase the vertical pressure on the outer rail the center bearing of the truck can be made wide, thus allowing the vertical component of the lateral pressure at the center of

gravity to be transferred through the bearing to the wheel, or with the narrow center bearing the height may be made such that the lateral pressure at that point will result in an increased vertical component independent of the height of the center of gravity.

It is the writer's opinion that the double end locomotive, while its characteristics are different, can be designed for high speed with safety equal to the single end locomotive, and this regardless of the height of the center of gravity.

ADAPTABILITY TO SERVICE CONDITIONS

The electric locomotive, besides being required to operate in either direction, is often also required to be adapted for operating high speed passenger trains and heavy low speed freight trains over main line tracks, to negotiate sharp curves, and to be easy on light track and bridge structures. With locomotives having geared motors, the requirement of operating the passenger and freight trains can often be met by changing the gearing to obtain the proper speed and draw bar pull. The running gear can be made with trucks of short wheel base and coupled together, the number of trucks depending upon the required weight of the locomotive for its maximum draw bar pull, and also on the allowable weight per axle. With such a design curves of very short radius can be operated over and the weight per axle can be such as to allow operation over light structures.

RELIABILITY IN SERVICE

When the design is such that it is safe to operate at the required speeds and is proper for the curves and other service requirements, and a liberal factor of safety is provided for the parts subjected to strain, the reliability in service affected by the mechanical part of the locomotive depends mainly upon the bearings, their lubrication, and the method of power transmission from the motors to the drivers. It is necessary therefore to provide effective lubrication and as few bearings and as simple driving mechanism as the design of the motors will allow.

After providing all the safety appliances recommended by the Interstate Commerce Commission, it is important to arrange for the most convenient location of the operator to allow him an unobstructed view of the track and signals, to place within easy reach the air brake valve and locomotive signal device handles, as well as the reverser and power controller handles, keeping in mind the importance of making them so free from complication that the operator will require the least amount of thought to manipulate any of the devices and be free to respond to signals and look out for emergencies.

The arrangement for housing the electrical apparatus and its position in the cab must be governed largely by its design, but it is important to arrange it so that its operating parts are accessible and easy to inspect, and at the same time are protected against persons coming in contact with any live parts.

POWER EFFICIENCY

The power efficiency as affected by the mechanical design is governed largely by the type of the traction motors. It is apparent that the gearless motor mounted directly on the axle allows the design of the maximum efficiency on account of its few bearings and its absence of gearing and moving parts. The gearless motor which is mounted on a quill and driving through springs to the wheels may be considered second in its possibilities for high efficiency design, it having additional bearings and a greater number of moving parts. The single reduction geared motor with its additional bearings and gear losses can be given third place in its possibilities for high efficiency design. The single reduction geared motor driving through gears and side rods to the wheels may be placed fourth. The gearless motor driving through side rods and jack shaft to the wheels should be placed fifth.

SERVICE TIME FACTOR

The service time factor is dependent upon the ability of the locomotive to operate under all its service conditions and without undue strains which requires a liberal design of its wearing parts. In addition to this it depends on the simplicity of its design and the ease with which its parts can be inspected, adjusted, repaired, or replaced.

COST OF MAINTENANCE OF PERMANENT WAY

The cost of maintenance of the permanent way is a very important item and can be increased or reduced by the design of the locomotive. The lowest cost is obtained when the locomotive meets its service requirements without undue strains, when the rotating parts are balanced, the weights per axle are suitable for the structures, a suitable equalizing system is provided to maintain the proper weight distribution, and when provision is made to protect against flange wear.

COST OF MAINTENANCE OF LOCOMOTIVES

The cost of maintenance of the locomotive is dependent upon its safety of operation, its adaptability to service conditions, its reliability, its convenience of arrangement, and the same items that enter into its service time factor. It is also governed by the same conditions as affect the maintenance of the permanent way. The care with which the material is selected, the quality of workmanship, the ease with which the parts can be inspected, adjusted, repaired or replaced, and the simplicity of the design are the most important features that govern the maintenance cost.

FIRST COST

The first cost of a locomotive will depend largely upon the design chosen, but its importance, except at the time of purchase, becomes of little moment when taking into consideration the eight foregoing features. With two locomotives designed for the same service the cost of the difference in the efficiency and in the locomotive maintenance alone for one year may when capitalized amount to a sum representing a considerable proportion of the first cost of one of the locomotives.

The writer feels that too much importance cannot be given to developing to the utmost the mechanical parts of the electric locomotive, that are the simplest in design and the highest in efficiency. From the present outlook, the locomotive for high speed passenger service with the gearless motor, its armature being mounted directly on the axle, and the locomotive for freight and switching service with the single reduction geared motor, mounted on and geared to the axle, lend themselves best to simple design and low cost of maintenance.

Acidity of Lubricating Oils.—It is necessary for oil to be as free from acid as possible, and to determine whether it is or not the oil should be placed in a glass vessel and a small quantity of copper oxide added. Should there be acid present, the oil will change to green or blue; if not, no change will take place. Litmus paper can be used for the same test, as it turns red when there is the slightest trace of acid.—*Power.*

Colored Glass as an Aid to the Fireman.—The condition of individual fires cannot be judged with the naked eye. Some sort of colored glass in a frame, hung directly where it is to be used, gives the operator a better means of judging the thickness of fires, movement of the fuel bed and the presence of holes or dirty places, so that he can judge the rate of supply of fuel and air to maintain a uniform thickness of fires so necessary to give the best furnace conditions.—*Sibley Journal of Engineering.*

TRAVELING ENGINEERS' CONVENTION

President's Address and Reports on Mechanical Firing of Locomotives and Smoke Elimination

THE twenty-fourth annual convention of the Traveling Engineers' Association was held at the Hotel Sherman, Chicago, October 24 to 27, inclusive, President J. R. Scott, assistant superintendent of locomotive performance, St. Louis & San Francisco, presiding. The secretary reported a total membership of 1,056 and the treasurer a cash balance of $4,080.75.

PRESIDENT'S ADDRESS

The whole aim of this association is an educational one. It brings together trained men from all sections of the country, who by working under a variety of conditions, are in a position to exchange ideas, not only on the convention floor, while discussing subjects, but in casual conversation during intermissions, also in the exhibit room, while viewing the modern equipment so extensively brought before us for exhibition and inspection. The knowledge thus gained is disseminated by us to others, and especially to our enginemen, who by constant instructions and training become more proficient in their work, and render better service to the companies by whom they are employed. The exhibits are more extensive this year than ever before. It is therefore desirable that all who can, should avail themselves of this splendid opportunity for educational advancement by carefully examining them. With the modern power of today, we are confronted with many problems that did not exist with the smaller power of the past, and as new appliances are constantly taking the places of the old, it behooves us as traveling engineers or representatives of our employers in whatever capacity, to so familiarize ourselves with all things surrounding our work, that we may be ever ready and willing to direct or assist others, and for which a convention of this character is most profitable.


J. R. Scott, President, Traveling Engineers' Association

As a direct result of the great European conflict more than any other cause, the cost of structural materials, metals, and supplies of all kinds necessary for railroad operation, also equipment for construction and maintenance work, has soared high in price. This together with the increased wages of labor, and lack of corresponding returns with which to meet the abnormal operating costs has created a burden which falls most heavily upon all railroads. In order that we may do our part to assist in relieving this unusual strain, we as traveling engineers, should zealously guard the machinery, fuel and supplies under our charge, that the best possible use may be secured from them. Much can be done along these lines by educational meetings wherein the importance of conserving materials and supplies is impressed upon the men. More skillful operation of the locomotive on the road, and greater conservation of supplies and equipment placed on them, together with increased efficiency in the handling of trains are matters that will tend to reduce cost of operation. Therefore, we should give our attention and special effort to bring locomotive operation to the highest possible standard of economy and good service.

Another matter of unequalled importance is the question of the great railroad strike, which was recently threatened by the four brotherhoods, representing more than 400,000 trainmen and enginemen. Such a strike, regardless of the cause, would have been a calamity beyond words to express, or thoughts to imagine. Although men may differ in opinion as to the action taken to avert this strike, none should differ in opinion as to the importance of warding it off, or the necessity of greater preparedness by national law, to protect the one hundred million people of this nation, their transportation facilities, their properties and industries.

ADVANTAGES OF MECHANICAL STOKING

The managements depend largely upon us to supervise the fuel expense, representing approximately 25 per cent of transportation expenses, and see that locomotives are in such condition and so equipped and handled that as nearly as possible the maximum rated capacity will be maintained.

The feeding of fuel into locomotive fireboxes by mechanical means has passed the experimental stage, and locomotives are operating at a mechanical efficiency of from 85 to 100 per cent, hauling trains and effecting operating economies that would not be possible under ordinary hand firing conditions. The application of appliances for firing solid fuels mechanically has made quite rapid strides since 1912, and there are now about 1,900 engines fired in this manner.

The average tractive effort of all locomotives in the United States has increased in the past ten years 38.6 per cent; the heavy locomotives of years ago ranging from 36,000 lb. to 42,000 lb. have given place to those ranging from 54,000 lb. to 160,000 lb., and the figures are increasing yearly. The average tons handled per freight train has increased 54.1 per cent in ten years. The gross ton-miles handled per locomotive has increased 11.6 per cent, which shows that we are not getting the full benefit of the increase in tractive effort. With the introduction of larger power units and resultant increased train load, various devices were introduced to secure the rated maximum capacity of the locomotives, such as brick arches, superheaters, etc., but the amount of coal consumed by a locomotive for a trip remained stationary or increased, with the result that those roads using heavy power experienced serious difficulty during the summer months in retaining experienced firemen in service and securing new men of the caliber that it could be expected would later develop into proper material for promotion to engineers. Therefore, if the heavy tonnage trains on the roads in question were to be a success and the cost of operation held to a minimum, the necessity for the "iron fireman" was apparent.

The following figures covering the four railways using the largest number of locomotives with appliances for feeding

fuel mechanically, and by which a large proportion of their freight traffic is handled, show interesting comparisons of average trainloads. (The figures are taken from reports made to the Interstate Commerce Commission.)

Fiscal Year Ending June 30, 1915, Compared with Fiscal Year Ending June 30, 1904

	Increased average tractive power (Per cent)	Increased average number of tons of freight per train load (Per cent)
Road A	43	78
Road B	40	72
Road C	30.7	72
Road D	29	54

(The locomotive fuel cost per ton mile on each road shows a decrease for 1915 as compared with 1904.)

This study is not intended to show that the method of firing the fuel is entirely responsible for the results obtained, as many features, such as brick arches, superheaters, improved design, change in line, and increased activity on part of the transportation officers in more closely following the proper loading of locomotives, have all had a bearing on the matter, and it should be remembered that in all cases of application of appliances for mechanical firing the locomotives were also equipped with the brick arches and superheaters.

The results that are being obtained from mechanical firing of the fuel may be summed up about as follows:

Increased Tonnage.—It has been reported that on some roads the trainload has been increased from 8 to 15 per cent as compared with hand firing, with much the same conditions as to grade and time. Such increase, it will be understood, can only be expected with large power where the advisability of the use of the stoker is clearly indicated.

B. J. Feeny, Vice-Pres., Traveling Engineers' Association

Increased Speed.—The experience of most roads is that better time is made with the same tonnage on the same grade than with the hand fired engine. The following is quoted from report made by one road:

"It is a daily occurrence on —— Division for trains hauled by stoker fired locomotives to overtake trains hauled by hand fired locomotives, and to reduce speed on this account. If all the locomotives on the division were equipped with stoker, there would at once be a further increase in the speed at which trains are put over the road, and this would be more noticeable at periods when the traffic is heavy and line congested, and, therefore, when it is most desirable."

Saving in Labor of the Fireman.—With the type of appliance in most general use, the coal placed in the firebox ranges from 85 to 95 per cent of the total fuel fired. Some trouble has been experienced due to the back corners of the firebox not being filled properly, resulting in the necessity for some hand firing. In this connection, the following comparison of the amount of manual labor connected with firing, compiled from accurate stop watch records made by competent observers, is of interest:

How fired	No. trips	Type engine	Avg. tons in train	Average period on duty (A)	Average manual labor supplying coal to firebox (B)	Per cent (B) to (A)
Hand	15	Mikado	2,868	11 hr. 3 min.	2 hr. 22 min.	21.5
Stoker	22	Mikado	3,364	12 hr. 34 min.	0 hr. 30 min. 21 sec.	4.5

Elimination of Necessity for Second Fireman.—The manual labor of supplying fuel to the firebox has been so largely reduced as to settle this question permanently, and on some roads where assistant firemen were provided for certain parts of the runs during the warm months, it is no longer necessary. There has been no necessity for shoveling coal ahead by laborers at intermediate points where it had been necessary during the warm months with hand firing.

Shaking Grates.—When the appliances and fire are properly handled, it has been the experience of some roads that grate shaking between terminals is not necessary. While in some localities the character of the coal is such that some shaking is required, with the thinner fire carried as compared with hand firing, less of it is indulged in. The thinner fire also results in saving time in cleaning fires.

H. F. Henson, Vice-Pres., Traveling Engineers' Association

Firemen Follow Engines More Regularly.—On account of the reduced physical labor connected with their duties, firemen are inclined to follow their engines resulting in reduction of extra lists, raising standard of new men employed and providing opportunity for better training, so that the firemen will eventually become better engineers.

Reduced Number of Engine Failures.—Fewer failures are the rule, due principally to ability to largely overcome defects, such as leaky superheater units, firebox sheets, flues, cylinder packing, valves, etc., which often make it necessary for hand fired locomotives to set off trains. (And likewise this same feature will often cause an increase in fuel consumption, on account of the likelihood of the engine being despatched with such defects as would most likely be remedied on the hand fired engine.)

Length of Run Increased.—It has been found on some roads that locomotives could be operated successfully and continuously over two divisions, when this was found impossible under hand firing conditions.

W. L. Robinson, Vice-Pres., Traveling Engineers' Association

Smoke Emissions.—On the line of road with engine using steam it has been found that the density of the smoke can be kept uniform by very careful manipulation. In some restricted smoke districts where more or less switching of the train is necessary, it has been found that in starting with a train after the fire has been built up, the smoke emission cannot be controlled as well as under hand fired conditions where run-of-mine or lump coal is used.

Fuel.—Grades of coal, such as nut pea and slack or screenings can be utilized successfully. As to the relative value of four grades of coal found on one road, the accompanying

table and analyses covering five round trips with each grade made under the same conditions will be of interest.

Attention is called to fact that except when haul is small, the use of low volatile screenings is prohibitive, due to their slower burning properties and resultant loss on account of being drawn through the flues and out of the stack when the locomotive is being worked to capacity. It has not been found possible to maintain maximum steam pressure with the slack coal hand fired.

The broadening of the market for fine coal brought about by the increase in number of mechanically fired stationary and locomotive boilers, has greatly narrowed the margin of difference in price of fuel used on hand and mechanically fired locomotives, it having been necessary in some instances for crushers to be installed in order that coal of proper size for use with some types of appliances might be provided.

G. A. Kell, Vice-Pres., Traveling Engineers' Association

Consumption of Fuel.—Burning either the same grades of fuel on both, or run-of-mine or lump on hand fired and screenings on mechanically fired locomotives, the consumption on a pounds unit basis is higher with the latter. It has been found, however, that locomotives can be operated with fine coal, such as it would not be possible to hand fire and allow the working of engine to be anywhere near the maximum.

Steam Pressure.—In this connection, a railroad officer, following up locomotive operation on a large road, declares:

"The maintenance of the maximum rate of steam production, utilizing full boiler capacity over extended periods at points where the maximum effort of the locomotive is required, has been a most potent factor in the improvement in the handling of trains."

A. G. Kinyon, Vice-Pres., Traveling Engineers' Association

Powdered Fuel on Locomotives. — The latest development for putting fuel into locomotive fireboxes, and which has been worked out to a practical basis within the past two years, is that of burning powdered fuel, a number of locomotives equipped for the purpose now being in operation and in the process of being equipped. As to the results that have been obtained in locomotive service, the following are the conclusions of the standing committee on Powdered Fuel of the International Railway Fuel Association, presented before the annual convention at Chicago, May 15, 1916:

"Summing up the results that are being obtained in locomotive service, these may be stated as:

"Smokeless, sparkless and cinderless operation.

"Maintenance of maximum boiler pressure with a uniform average variation of 3 lb. without loss through the pops.

"An increase of from 7½ to 15 per cent in boiler efficiency as compared with burning lump coal on grates.

RELATIVE VALUE OF COALS FOR STOKER FIRING

		Gas		Soft or low volatile	
		Nut-pea-slack	Slack	Run-mine	Screenings
Basis per horse power hour.	Lb. coal	3.88	4.23	4.32	5.17
	Relative lb. coal	100.00	109.00	111.19	132.98

Note: Nut-pea-slack—Coal passing through 1½-in. bar screen.
Slack—Coal passing through ¾-in. bar screen.

CHEMICAL ANALYSES OF COALS

Class of coal	Gas		Soft or low volatile	
Grade of coal	Nut-pea-slack	Slack	Run-of-mine	Screenings
District mined	Fairmont	Fairmont	Somerset-Meyersdale.	
Moisture	1.23	1.57	.75	.81
Volatile matter	36.47	35.74	18.17	17.52
Fixed carbon	53.94	52.78	69.07	70.06
Ash	8.36	9.91	12.01	11.61
Total	100.00	100.00	100.00	100.00
Sulphur	2.59	3.30	3.33	2.31
B. T. U. (calculated)	13,100	12,900	13,800	13,870
B. T. U. (by calorimeter)	13,910	13,790	13,880	13,970

"Saving of from 14 to 30 per cent in fuel of equivalent heat value fired.

"Enlarged exhaust nozzle area resulting in greater draw-bar pull and smoother working of the locomotive.

"Elimination of ash pit delays, facilities and expense and reduction in time required for and ease in firing up.

"Maintenance of a relatively high degree of superheated steam.

"No accumulation of cinders, soot or ashes in superheater or boiler flues, smokebox or on superheater elements.

"No punishment of or overheating of firebox, new or old sheets, seams, rivets, patch-bolts, stays or flue beads.

D. Meadows, Treas., Traveling Engineers' Association

"Elimination of arduous manual labor for building, cleaning and dumping fires and for firing.

"Avoids expense and annoyance for providing various sizes and kinds of fuels.

"Eliminates the necessity of front end and ash-pan inspection and for special fuels, firing tools and appliances for building fires and for stoking and cleaning fires.

"Equal provision with engineer for fireman to observe signals and track, thus reducing liability of accident.

"Your committee is of the opinion that the effectiveness and utility of fuel in pulverized form has been demonstrated from the past years' development and that the progress in the use of this method of stoking and burning bituminous and anthracite coals and lignites for generating power, heat and light on railways, will be quite marked from now on."

Conclusions.—The capacity of the power unit is largely dependent upon that of the boiler. With the increase in size of the locomotive, in the case of many new types the boiler has had to be enlarged to the extent of overreaching the limitations of hand firing, clearly indicating the necessity of introducing the fuel into the firebox by mechanical means. In fact, locomotives have within late years been constructed, the building of which would probably not have been attempted had not the practicability of this means of handling the fuel been established. There is little doubt that many

locomotives are in service the maximum capacity of which is not being obtained due to the limitations in connection with the ordinary methods of manual firing on grates.

The report was signed by: W. L. Robinson (B. & O.), chairman; E. Hartenstein (C. & A.); J. H. De Salis (N. Y. C.); M. J. McAndrew (M. C.) and E. A. Averill (Locomotive Feed Water Heater Company).

DISCUSSION

J. H. DeSallis, (N. Y. C.): On the Pennsylvania division of the New York Central there are 15 Mallet and one Consolidation locomotives equipped with stokers and superheaters. On the Mallet locomotives the nozzle has been increased from 6 in. to 7 in. in diameter. A low volatile slack coal is used in place of the run-of-mine which was used on the hand fired engines. However, there has been an increase in fuel consumption. The application of the stoker has entirely eliminated the requirement of a second fireman and the manual labor has been reduced to practically nothing, enabling the fireman to watch for signals. The grates are only shaken once over the 100-mile division and then not much. There has been some trouble experienced with foreign matter in the coal clogging the screw conveyor. The trouble with clinkers, which is found in hand fired engines, has been eliminated. The engine crews follow the engines more closely; they are in assigned service, and take more interest in the locomotive. Many firemen prefer these engines to local passenger runs. The smoke conditions have been materially improved and the steam pressure can be maintained better than on the hand fired engines. The train tonnage has been increased from 3,600 to 3,900 tons by the use of the stoker engines. Special men are assigned to care for these engines at the terminals.

W. O. Thompson, Secretary, Traveling Engineers' Association

F. P. Roesch, (E. P. & S. W.): On the El Paso & South Western there is a long pull of 117 miles with one per cent grade and another one per cent grade of 38 miles. In hot weather it has been found necessary to reduce the tonnage on the hand fired engines, but the stoker engines are loaded to full capacity. While more coal is used by the stoker engines it costs only $2.10 per ton as compared with $4.65 paid for the coal used on the hand fired engines. It is now planned to put the stokers on some passenger engines which are called upon to handle 14 steel cars over the long one per cent haul.

J. Keller, (L. V.): A stoker fired engine should be handled with as much care as the hand fired engine, as by forcing it unnecessarily hard there will be a waste of fuel. The coal should be fed in small quantities and should be controlled by regulating the speed of the apparatus. There is a need of a stoker for burning low volatile coal such as anthracite.

H. F. Henson, (N. & W.): It is quite necessary to carefully educate the firemen in the handling of the stoker and it requires intelligence to get the most out of an engine so fired. The stoker engines will handle more tonnage and get over the road more quickly than the hand fired engine and for that reason they are favorites with the transportation department.

W. W. Shelton, (C. & O.): Special men are assigned to take care of the stoker engines. The cost for maintenance, including labor and lubrication, is 50 to 60 cents per 100 miles. With wet coal occasioned by heavy rains steam failures are liable to result. More trouble is experienced with clinkers than on hand fired engines with slack coal. The nozzles of the stoker engines have been increased from 6¼ in. to 6½ in. in diameter.

A. W. Willsie, (C. B. & Q.): The stoker engines on the Burlington use screenings passing through 2 in. round hole screens. It has been found that coal prepared on a round screen will be distributed better by the stoker than when it is prepared through the shaker bars. The stoker engine must be handled with care and the fire watched to see that proper distribution is being obtained.

Other speakers stated that after the men had once fired a stoker engine they would handle a hand fired engine more intelligently. Mr. Robinson in closing the discussion stated that from a six months' observation of Mikado engines on the same division it was found that the coal consumption per ton-mile varied as follows: Hand fired—100 per cent; stoker fired (assigned service)—110.8 per cent, and stoker fired (pooled service)—114.8 per cent.

ADDRESS BY MR. McMANAMY

Frank McManamy, chief inspector locomotive boilers, Interstate Commerce Commission, addressed the convention during the Wednesday morning session. He spoke chiefly on the locomotive inspection rules, calling attention to the fact that the railroad company was held responsible for the general design, construction and maintenance of the locomotive and tender. The daily inspection reports serve to protect the mechanical offices in charge of the equipment, especially where engines are ordered out before proper repairs have been made. The purpose of the law is to do what the motto of this association states, namely, "To improve the locomotive engine service of American railroads." The safe operation of the railways depends upon two things—good locomotives and competent men to operate them.

SMOKE ELIMINATION

The chairman of this committee recently read a book on the Steam Engine, the fifth edition of which was printed in 1836, in which the author stated that one of the chief barriers to cheap transportation was the enactment of a law by the English Parliament, forbidding the use of bituminous coal on locomotives because of the smoke nuisance. More real progress in smoke abatement has been made in this country within the last five years than had been made in 50 years previous to this period. This great and permanent advancement was obtained through the executive heads of the railroads taking hold of the question. To some extent this was forced on them by legislative action, which in many cases was unreasonable. The willingness of the city authorities to be fair with the railroads has resulted in the managements of the roads spending large amounts of money on experiments, education of the men and supervision.

The smoke problem is a question of perfect combustion. The nearer we come to it the nearer we are to smokeless operation, but when the varying conditions under which a locomotive is operated are considered it is not an easy matter. At times it is necessary to burn as high as 150 lb. of coal per square foot of grate surface per hour, a condition that few combustion engineers ever consider in advocating smokeless operation. We will admit these are extreme conditions and the facts are that the complaints of smoke violations come more frequently from more favorable conditions where the violation could have been avoided with proper care by the engine crews. Of course there are cases where the engine crews are not responsible. One of these is where the power is in poor condition, but the great majority of these cases were caused by carelessness of the engine crews. The men

are educated to regulate the fire so that only the minimum amount of smoke will be made and the great majority never give cause for complaint. But we find certain men in all walks of life who do just enough to get by. These are the men that one has to contend with in handling the smoke problem. This same class is responsible for the railroads of Chicago spending $65,000 a year for supervision and proportionate amounts in other cities.

There is no question but that seniority as conducted today, encourages this class of men and is an injustice to the man who takes a pride in educating himself and doing things the best he knows how. On the other hand those of us who are old enough to have worked under conditions existing before seniority became general, still believe it to be a lesser evil than favoritism. The main objection to seniority is that it has no incentive for a man to do things as they should be done. One thing that could be done without affecting senior rights would be to make a record of the men at stated periods. This would be along the lines followed some years ago on many roads when each engineer received an individual performance sheet monthly, showing the number of miles made by his engine, the cost for fuel, oil and repairs, the engineers' and firemen's wages, wipers' wages, average cost per hundred tons per mile and all details pertaining to the operation and maintenance of their engine. It would in our opinion result in saving the present cost of supervision needed to keep smoke elimination within the limits which are required.

Human element enters largely into the matter of smoke prevention, regardless of any and all known mechanical devices. The stoker fired engine when handled intelligently is practically smokeless as well as being a fuel saver when size of engine and tonnage rating is considered. Perhaps the nearest approach to smoke elimination in the operation of locomotives will come with the use of powdered coal, now being experimented with on several railroads. The use of powdered coal will afford a more perfect combustion of the fuel than is otherwise possible, which will of course be a great advantage, but in spite of that fact there will ever be a need of the faithful and intelligent co-operation of the engine crews. This latter factor really represents the most difficult feature of the whole problem.

The report was signed by Martin Whelan, chairman.

DISCUSSION

W. L. Robinson, (B. & O.): It is not necessary to discipline the men for bad smoke performance. Records should be kept of each offence and explanations called for. Let the men know frequently where they stand and if impossible to get a good performance they should be transferred to other districts. Close supervision is necessary. In Washington, D. C., every smoke emission lasting more than 10 seconds for black smoke and 30 seconds for dark gray is recorded. No smoke prevention devices are used except the brick arch. The placing of the smoke consumers on an engine admits that it is impossible to have smokeless firing. The stoker engines give the greatest trouble.

E. F. Boyle, (Sunset Central): At the bottom of the work reports the question is asked as to whether the engine steams poorly or if it smokes. In case they do they are examined carefully and if they are found in a satisfactory condition the engine crews are called upon to explain. Oil burning locomotives can smoke as badly as any coal burner and they must be carefully watched.

W. H. Corbett, (M. C.): In case of a second violation the offender is given a suspended sentence of 5 days which is held over him for a year. At the end of that time if he has an otherwise clean record it is removed. The brick arch and the steam jet smoke consumer used in the vicinity of Chicago give excellent results.

C. W. Corning, (C. & N. W.): When firing up a cold engine, by placing the coal on the grates and covering it with kindling such as edgings from the mill and igniting it with waste saturated with coal oil a fire can be started with but very little smoke. The fire up man can also handle more engines in this way than he could otherwise. The engines must be maintained in good condition to insure smokeless operation.

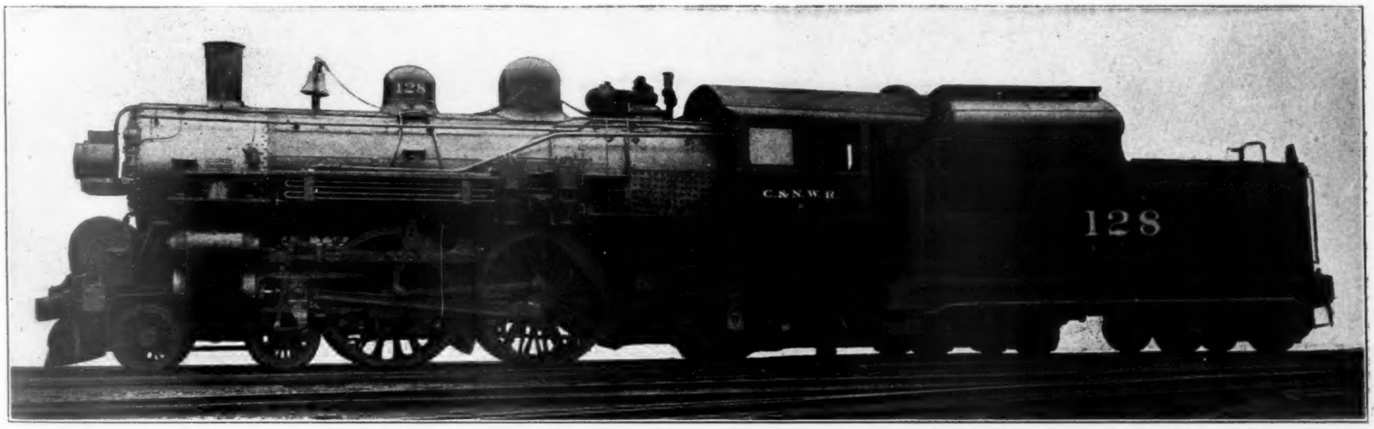
[Note.—The report of the remainder of the convention proceedings will be published in the December issue.—Editor.]

POWDERED COAL IN ENGINE SERVICE*

BY C. W. CORNING

Chief Service Inspector, Chicago & North Western

Powdered coal has been used successfully and rather extensively for many years in cement and metallurgical furnaces, but its use for making steam has been limited, due, perhaps, to the lack of practical development. A cubic inch of solid coal exposes only 6 sq. in. for absorption and liberation of heat; a cubic inch of powdered coal exposes from 20 to 25 sq. ft., which enables a more uniform gas production from the volatile matter in the coal, and a more prompt and perfect intermingling of the gas and air, thereby improving combustion and reducing smoke.



Chicago & North Western Pulverized Fuel Burning Locomotive

In July, 1915, the Chicago & North Western equipped one of its Atlantic type passenger locomotives for burning pulverized coal. This engine was placed in service August 8, 1915, and was given severe tests in heavy through and suburban passenger service as well as on transfer runs, and has never failed to produce the desired results. The physical

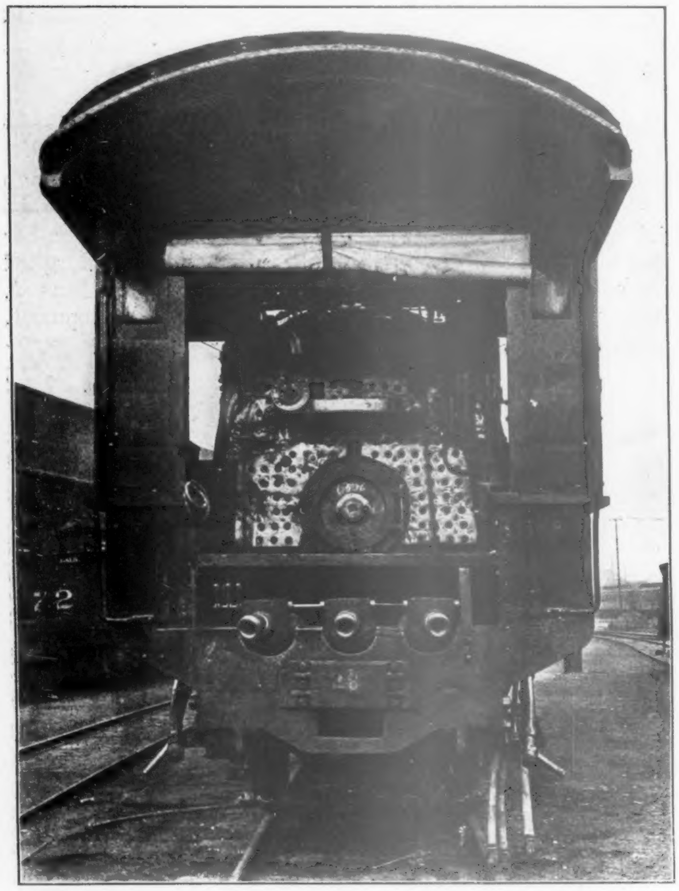
*Presented at the recent convention of the Smoke Prevention Association, held in St. Louis.

characteristics of this locomotive are shown in the table:

Total weight of engine	180.000 lb
Weight on driving wheels	96,000 lb.
Tractive effort	21,850 lb.
Cylinders, diameter and stroke	20 in. by 26 in.
Driving wheels, diameter	81 in.
Size of firebox	108⅛ in. by 65¼ in.
Firebox heating surface	170.7 sq. ft.
Total heating surface	2,770.7 sq. ft.
Superheating surface	428 sq. ft.
Steam pressure	185 lb.

The equipment installed in this engine was obtained from the Locomotive Pulverized Fuel Company, New York, and was the second installation of its kind in this country. On this locomotive, however, the feeding mechanism and fan blowers are operated or are driven by electric motors which receive their electrical energy from a Curtis turbo-generator located on the front of the engine, which it should be remembered is only a temporary expedient. Since this installation a variable speed steam turbine has been developed for driving this feeding mechanism which is more simple in operation and less complicated in construction and more economical.

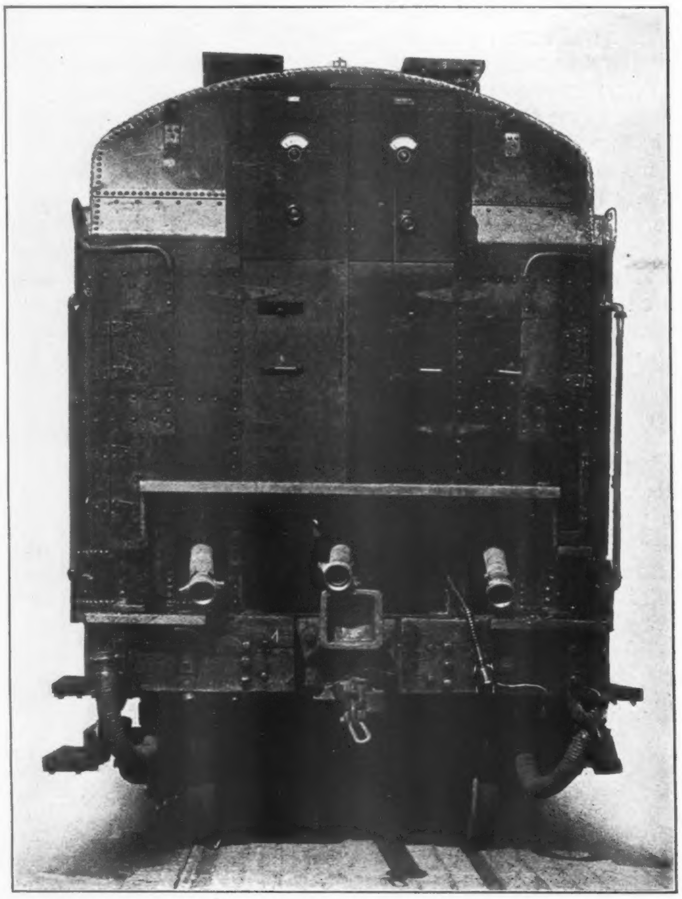
The powdered coal is contained in an enclosed tank on the tender. In the bottom of this tank there are three screw conveyors, which bring the fuel to the feeders where it commingles with the air from the fan and is blown through the flexible conduits into the nozzles and from there to the three burners which enter the firebox just under the mud-ring.



Locking Into the Cab of the North Western Locomotive

From the flexible conduits the coal and air mixture passes the mixing chambers to the burners where additional air is automatically admitted by induction according to the amount of fuel being used, before it reaches the burner outlets. The dampers in the mixing chambers are under the direct control of the fireman and are used to adjust the volume and velocity of the induced air supplied at this point when the engine is using steam, and to shut off the air supply when standing or drifting. The speed of the screw conveyors in the tank also is controlled by the fireman, all the controlling apparatus being conveniently located so that it is very seldom necessary for the fireman to get off the seat, where he can keep a constant lookout for signals.

From the burner outlets the fuel and air passes into the gasifying chamber, which is formed by a primary arch located just over the outlet of the burners, and from there into the combustion chamber. The products of combustion pass forward and up and along the bottom of the brick arch, thence over the top and along the crown sheet into the tubes. This brick arch, however, is the standard locomotive brick arch set close against the flue sheet and extending one brick



Front End of the Tender of the North Western Locomotive

higher than those used in the same type of engine hand fired. This increases the flame travel and the evaporation efficiency of the back head of the firebox.

It was expected that some difficulty would be experienced in the life of the brick work as well as from a firebox with half side sheets, but due to the action of the flames, which have a rolling rather than a blast action, no trouble has been experienced, in fact, it has been conceded by the boilermakers that the firebox is in better condition than it would have been if placed in hand-fired service, because of the even temperature maintained and no cooling effects from opening the fire door.

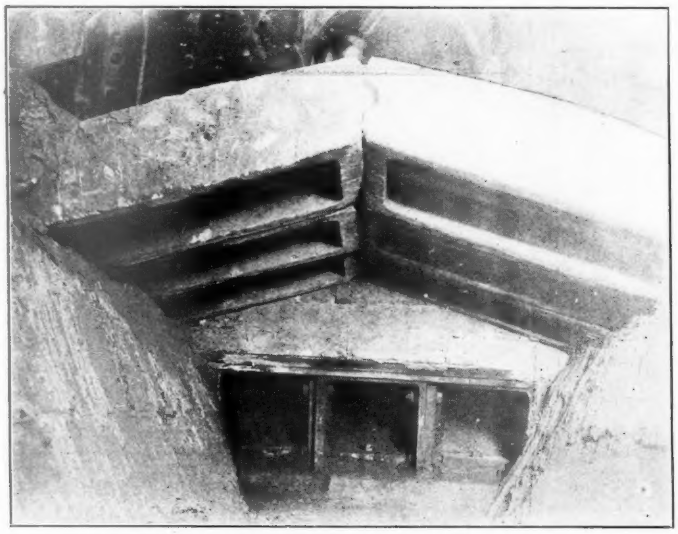
The use of this apparatus has increased the capacity under which this boiler may be operated to the extent of three 4-in. safety valves which are required to properly relieve the boiler, where three 3-in. safety valves is the standard for this type of engine under hand-fired conditions. It is possible, also, to increase the size of the nozzle, thereby reducing back pressure and wear and tear on machinery, and making it a smarter engine.

A most important factor is to have the coal properly prepared. The best results cannot be obtained unless the pulverized coal contains not to exceed one per cent of

moisture, and is milled so that 85 per cent of the total will pass through a 200-mesh screen, and 95 per cent. of the total through a 100-mesh screen.

The control of the fire is such that while standing at stations it can be extinguished entirely to prevent waste of steam through the pops. On several occasions where it was necessary to wait from 15 to 45 minutes in terminal stations before leaving time the fire was always extinguished, and then relighted from 3 to 5 minutes before conductor gave signal to start.

The firing up of this locomotive is very simple. In firing up the locomotive in the roundhouse all that is necessary is to apply about a pound of lighted waste which has been saturated with fuel oil to the outlet of one of the burners, then start the feeding mechanism and the coal will ignite. A blower must be used at all times when fire is burning and throttle is closed in order to induce the combustible mixture into the furnace. The emission of smoke is practically negligible. In firing up an engine which is cold, and roundhouse steam is being used for the stack blower as well as to drive the turbine, the smoke reading has read one-half of one per cent according to the Ringelmann chart for from 5 to 10 minutes. As the brick work in the firebox becomes heated this gradually disappears. When engine is being worked on the road pulling a train the operation is absolutely smokeless. There are no sparks nor cinders emitted from the stack at any time.



Looking Toward the Back of the Firebox, Showing the Primary Arch and the Burners

A very noticeable feature in the initial firing up process of this engine is not alone the ease with which this can be accomplished, but also the small amount of coal consumed and the rapidity with which the steam can be raised from cold water, which is from 50 to 60 minutes. Several tests show that 750 lb. of coal is the average amount used to obtain full boiler pressure as against 1,700 lb. of coal as used on a hand-fired engine of the same class. However, it must be remembered, in comparison, that the hand-fired engine has a fuel bed still on the grates which possesses considerable heat energy. On the other hand, the pulverized coal engine has much more brick work in which a large amount of heat will be stored during the firing-up process.

Perhaps this feature of firing-up, especially to railroad men who have to do with the firing-up of locomotives and getting them out on their various schedules, will be most interesting. It is possible to fire-up this type of locomotive, raising the boiler pressure to the maximum, then shutting the fire off by stopping the supply of fuel, and then allowing the engine to stand for several hours without any further attention. All that is necessary is to relight the fire about 5 minutes before engine is due to back out of the house, providing boiler pressure has not fallen below 60 lb. In fact, on several occasions the engine has stood 8 hours in the roundhouse and fired up again with its own steam.

Among the many benefits enumerated, the elimination of the ash pit appeals to the smoke inspector very strongly, there being no necessity for cleaning fires, as the only non-combustible residue to be disposed of is the slag which is of a glassy nature and composed principally of silica, iron and aluminum, this being of a brittle, self-dumping and easily removable nature when solidified. The amount of slag as compared with the ash from the hand-fired engine is 4 per cent in the former and 15 per cent in the latter.

Characteristics of Fuel for Powdering.—It has generally been thought that for the burning of solid fuels in powdered form in suspension, a bituminous coal of less than 30 per cent volatile matter could not be used with satisfactory results. As the object is to convert the powdered fuel into a gaseous state as early during the process of combustion as practicable, this characteristic as regards the desired proportion of volatile matter, while desirable, has not been found to be essential. Satisfactory results are now being obtained in locomotive practice from semi-bituminous coals analyzing as low as 21 per cent volatile and having 15 per cent ash and moisture, and with mixtures of 40 per cent anthracite having 7 per cent volatile, and of 60 per cent bituminous having 24 per cent volatile, making an average of about 17 per cent volatile.

With pulverized coal it is entirely practicable with inferior grades of bituminous and sub-bituminous coals, such as mine refuse and sweepings, run of mine screenings, slaked coal and lignite, to operate with the results previously described. During the past year the fuels described in the following table have been successfully used while engine was performing regular service:

Looking Forward in the Firebox of the Pulverized Fuel Locomotive

Contents	Unwashed Screenings: Illinois Bituminous		Unwashed Screenings: Kentucky Bituminous	North Dakota Lignite
Moisture (per cent).......	From	3.18 to 15.36	1.9 to 2.8	1.8
Volatile (per cent)........	Average	34.0	30.0	47.25
Fixed Carbon (per cent)...	Average	47.0	54.0	40.91
Ash (per cent)...........	Average	10.0	8.0	9.32
Sulphur (per cent)........	Average	1.70	0.79	0.79
B. t. u..................	From	10,720 to 12,400	13,964	10,960
Fineness (per cent).......				
Through 100-Mesh.........	From	90.7 to 99.69	93.0%	98.
Through 200-Mesh.........	From	71.45 to 97.06	83.0%	95.9

During the period of experimentation, the most interesting feature was the tests that were made in April of this year, between Chicago and Milwaukee, a distance of 85 miles, comparing the pulverized coal engine burning pulverized

mine run Kentucky screenings, and another engine of the same type, hand fired, burning Kentucky lump coal. Both engines were equipped with superheaters, and a dynamometer car was used in all the tests. The following table gives the average results of these tests:

Locomotive number	128	127
Method of firing	Pulverized fuel	Hand
Kind of coal used	Ky. screenings	Ky. lump
Elapsed time (hours)	4.0276	4.0958
Running time (hours)	3.8687	3.9688
Tonnage	291	278
Number of cars	5.8	5.5
Mileage	170.79	170.75
Average drawbar pull (pounds)	2,711	2,527
Horsepower per hour	319.5	290.3
Coal used (tons), running	3.815	3.783
Water used (gallons), running	8,381	7,350
Coal per hp. hr. (pounds)	6.17	6.57
Water per hp. hr. (pounds)	56.48	54.14
Water evaporated per lb. coal (pounds)	9.15	8.09
Coal used for firing up† (tons)	1.569	2.775
Total coal used (tons)	5.384	6.558

†This item includes, in addition to firing up, the amount of coal used in taking the engine to and from the train and the amount used by the engines during the "dead" time.

From observations taken the gas analyses showed 13 per cent CO_2 when the coal was fired at the relatively low rate of about 3,000 lb. per hour, and is increased to 16 per cent CO_2 as the rate of combustion increases. At the same time the smoke box temperatures averaged 450 deg. F.

In conclusion, the results that are being obtained from this locomotive in service may be summarized as follows:

First—Smokeless, sparkless and cinderless operation.

Second—Saving of from 15 per cent to 30 per cent in fuel of equivalent heat value fired.

Third—The elimination of ash pits, their delays and expense, and the arduous labor of dumping, cleaning and building new fires.

Fourth—Enlarged exhaust nozzle resulting in smoother working engine, and increasing the efficiency of the boiler.

Fifth—Ability to maintain maximum boiler pressure under all working conditions.

Sixth—No special fuel required for firing up, thereby eliminating the enormous pile of wood or coke necessary for ordinary methods.

Seventh—The ability to make use of inferior grades of coal which cannot be utilized to good advantage otherwise.

Eighth—The firing of the boiler is entirely automatic. No fuel whatever is supplied to the furnace by hand shoveling. Less physical requirements in firing, as the fireman is relieved from manual exertion. To use the railroad colloquial of the day, it is not necessary to "choke the No. 6, throw in a slug, get up on the seat box and ride the fire out" while the Smoke Inspector is holding the stop watch and wondering whether or not the smoke will ever clear up.

THE POWER OF A HORSE LESS THAN A HORSEPOWER.—The power exerted by a horse when plowing and traveling 1.8 mile per hr. and pulling about 150 lb. amounts to 0.72 of the so-called mechanical horsepower. Dynamometer tests have shown as high as 200-lb. pull at the rate of 1.8 miles per hr. This amounts to 0.96 hp. It is therefore evident that when Watt determined the mechanical equivalent of a horsepower he selected a better-than-average horse. —*Power.*

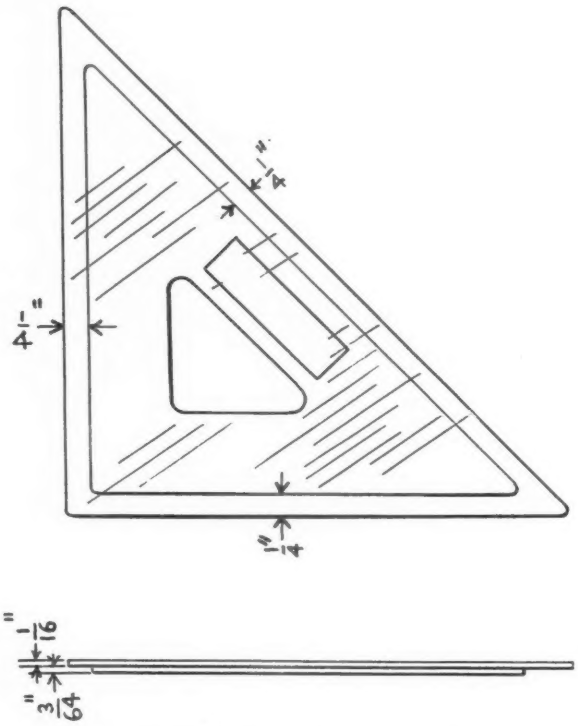
THE PROPER TOOL FOR TRUING GRINDING WHEELS.—The diamond tool is the most efficient means for truing the face of grinding wheels for precision work so far discovered. The reasons are: Diamonds or bortz are harder than the wheel to be trued; they are obtainable in sufficient quantities to meet the demand; they provide a means of making the wheel a true cylinder and at the same time provide any kind of wheel service desired; they lend themselves to a reasonably easy setting and are conveniently applied to the work, and the waste of the wheel is negligible.—*Grits and Grinds.*

TRIANGLE FOR USE IN TRACING

BY HUGH G. BOUTELL

The accompaning sketch shows a triangle which was developed by the writer and has proved particularly useful in tracing work where speed is essential. It is made up of two 45-deg. triangles, one enough larger than the other so that it projects about ¼ in. on all three sides. The two triangles are held together with Le Page's glue.

In tracing, considerable care is required to slide an ordinary triangle up to a freshly inked line without touching the wet ink. In the double triangle, the ¼-in. projection of the upper part obviates the danger of blotting the tracing. It also allows greater lateral freedom of the ruling pen and makes possible better matching up of straight lines and curves.



Convenient Triangle for Use in Tracing

RAILROAD COAL CONSUMPTION.—The railroads of the United States used 128,200,000 net tons of coal in 1915. This amounts to about 24 per cent of the total output. The bituminous mines furnished 122,000,000 tons, which is 28 per cent of their production, and the Pennsylvania hard coal regions supplied 6,200,000 tons, approximately 7 per cent of the total production.

SIZE OF STEAM PIPES FOR RECIPROCATING ENGINES.—Size of steam pipes for reciprocating engines operating at full stroke may be determined by comparing the diameter of the cylinder squared and multiplied by the piston speed per minute with the diameter, assumed, for the steam pipe squared and multiplied by the desired steam velocity. Example: The pipe size for a 20-in. cylinder and the piston operating at 600 ft. per min. is between 6 and 6.5 for a steam velocity of 6,000 ft. per min., since $20 \times 20 = 400 \times 600 = 240{,}000$, while for comparison $6 \times 6 = 36 \times 6{,}000 = 216{,}000$ and $6.5 \times 6.5 = 42.25 \times 6{,}000 = 253{,}500$. The 6-in. pipe would require a steam velocity of $240{,}000 \div 36 = 6{,}666$ ft. per min., while in the 6.5-in. pipe the steam velocity would be only $240{,}000 \div 42.25 = 3{,}857$ ft. per min. —*Power.*

Car Department

THOUGHTS SUGGESTED BY INDIANAPOLIS CONVENTION

The following thoughts were not necessarily expressed on the floor of the convention, but were suggested by some one or more of its varied activities. Editorial comments of special interest in this connection will be found on pages 549 and 550 under the following heads: "Higher Officers, Attention"!; "Uniform Interpretation of Interchange Rules"; "Loss and Damage to Freight"; and "Car Department Apprentice Problem."

What Manner of Men Are They?

It was my first experience in attending a convention of the Chief Interchange Car Inspectors' and Car Foremen's Association. Naturally the question foremost in my mind was as to how it would compare with similar meetings of the other railway mechanical associations. How would its members check up individually and collectively with those, say, of the General Foremen's or the Master Blacksmiths' Associations? How would they express themselves in the discussion of complicated questions? With what degree of executive and business ability would the proceedings be carried on?

Briefly, the gathering was large, the attendance good and consistent at the two sessions each day; the members, clean-cut in appearance and good at expressing themselves on their feet; the meeting notable because of the comparatively large number of the younger men in attendance—on the whole one could not but be favorably impressed with the appearance of these men and the manner in which they conducted themselves.

Car inspectors and car foremen! Officers in the mechanical and operating departments have sometimes elbowed them aside as if they were not worthy of or capable of the bigger things in the mechanical department. Times have changed. With the more severe and exacting conditions it has become apparent that just as high and possibly a higher degree of executive and technical ability is required to solve car department problems and handle the labor question as in the locomotive and operating departments. Indeed, in the struggle to hold down the operating ratio in the face of higher labor and material costs, increased taxes and greater expense entailed by state and federal regulation, it is quite probable that greater possibilities for increased efficiency lie in this field than in the other departments.

Sizing up roughly the men in attendance at this convention and comparing them with the personnel of the other associations it would appear that the men are available for this great task provided they are given proper encouragement—and the word "encouragement" is used in a large sense. Their suggestions and recommendations should be given a respectful hearing, and the fact that they are on the firing line and, if capable, are thoroughly familiar with the detail problems, should give weight to their recommendations. The higher officers, or the interests they represent, will be liable to pay dearly for carelessness or indifference to the opinions and suggestions of these men, and by the same token the car department officers and foremen should be firm and insistent in following up such recommendations as they may make, once they are sure they are in the right.

Big Possibilities Ahead

Heretofore the association has confined its work to the consideration of the interchange rules. Because of the probability of fewer changes in the rules in each succeeding year, the executive committee of the association decided last February to widen its activities and give more and more attention to car department problems other than those concerned strictly with the interchange rules. A study of the convention proceedings will show with what great success the new venture met, in spite of the limited amount of time available for getting it started. A most important factor in this success was the prize competition on car department apprenticeship. The association is under obligations to the donor of the prizes for following it up with a similar offer for the 1917 convention. Now that the ice is broken and the association has grown to a larger size, it is to be hoped that a greater number will take part in the second competition. And this is said with no reflection on the number which took part in the first one. It was splendid for a starter. The prizes are well worth striving for; the financial return, however, is only a small part of the reward to those who take part. The prestige that will come to the winners and the greater respect in which they will be held by their comrades is of far greater importance. Those who do not win will be amply rewarded by the effort which they will make. It will crystallize their ideas and start them at work in the local solution of the biggest problem which today confronts the car or any other department of a railroad.

Stumbling Blocks

The use of the word "reasonable" without qualification in legal enactments has cost millions in litigation. In a smaller way, the expression "unfair usage" in some of the interchange rules and the wording of paragraph 2 in Rule 4 are about as troublesome. The latter paragraph reads: "Defect cards shall not be required for any damage that is so slight that no repairs are necessary." Because the inspectors fear that they will be criticised, many defect cards are applied that under this rule are not required. The delays and useless expenditure of time and money thus caused amount to a large item on many of the roads. This rule stirred up far more discussion than any other; the final recommendations of the convention as to its application will be found in the report of the convention proceedings.

Saving Time in Meetings

While the work of the convention was handled in a most expeditious manner, it may be well to see if there is not some way of still further conserving the limited amount of time which is available for the meeting. This is necessary because there will always be more problems requiring discussion than can be handled in a three days' convention, and it is hardly wise to try to hold the members for a longer time. An important factor in conserving the time this year was that the officers were always on hand and in place well in advance of the announced time of the meet-

ing and the gavel came down with a thud on the exact minute. It would seem advisable for the officers or the executive committee to appoint some member or a small committee in advance to study the changes in rules and be prepared to state concisely and clearly the changes which have been made in each rule so that the complete reading of the rule will be unnecessary. In addition, each member should be fully prepared in advance to ask questions concerning its application or to make suggestions. Considerable time was lost on several occasions because members asked questions apparently on the spur of the moment and without any real thought or study as to the special application of the rule. This is not fair to the rest of the members.

Protecting the Stockholders

In welcoming the convention to Indianapolis the corporation counsel emphasized the importance of the car inspector's and car foreman's work from the standpoint of protecting the traveling public from danger. And surely this cannot be overestimated. Of first importance also is his work in protecting the railroad from loss due to accidents and losses in operation caused by delays due to defective equipment; then, too, there is the large item of loss and damage to freight. A further item of no small importance which has developed rapidly in recent years was expressed by one of the members in the words "protecting the directorships against penalties assessed for the infringement of the laws." Safety appliance legislation and other acts have added not a little to the responsibilities and duties of the car inspector. Likewise it requires greater responsibility on the part of each road in selecting and training the men better to discharge these duties. Unfortunately some roads do not seem to have awakened to their full responsibilities in this direction.

WORK OF THE ASSOCIATION OF MANUFACTURERS OF CHILLED CAR WHEELS*

The work of our association during the past year has been based upon the recommendations made to the Master Car Builders' Wheel Committee during the year of 1914. Our recommendations were substantially as follows: First—an increase in the weights of the 625 and 725 lb. M. C. B. wheel; second—an 850-lb. wheel for cars of 140,000 lb. capacity; third—a flange for the 850-lb. wheel for use under the 70-ton cars with as much of an increase as would be acceptable to the American Railway Engineering Association.

Since our organization in the year 1909, we have steadfastly maintained that the varied service in the 60,000-lb. capacity class of cars made it imperative that the weight of the wheel should either be increased to meet the maximum conditions of service, or that we should have two standards in this class. The variation in service arises from the variations in the light weight of cars of 60,000-lb. capacity, and as the standard of operation is to brake the cars 60 per cent of their light weight it must follow that any class of cars in which there is 100 per cent variation in light weight, which is common in the 60,000-lb. class, cannot with safety carry the same weight of wheel. But this is what the manufacturers have been required to do.

The standard wheel specified for 60,000-lb. capacity cars weighs 625 lb. and the light weights of the cars vary from 20,000 lb. to 53,000 lb.

Our association recommended that the weight of the wheel be increased to 675 lb. which would provide a standard wheel to meet the maximum conditions of service as to load and brake, and in asking for an increase in weight of the 625-lb. and 725-lb. M. C. B. standard wheels, we were not actuated by commercial considerations.

It is estimated that there are 2,500,000 chilled iron wheel renewals annually and if the weights should be increased 50 lb. each the additional metal to be purchased would approximate 62,500 tons, providing all the renewals required an increase. This is by no means the case, because many of the prominent railroads in the country, representing over a fourth of all the cars in use, are already introducing advanced standards and are using wheels much heavier than the present M. C. B. standards. The heaviest 725-lb. M. C. B. standard chilled iron wheel for 50-ton cars is lighter than the rolled steel wheel and there is no good reason why the chilled iron wheel should be so limited in weight.

Our association has made a very satisfactory arrangement with the University of Illinois through Dean W. F. M. Goss, in which it is agreed "that the University experiment station will undertake an investigation concerning the stresses and behavior of chilled iron car wheels." In submitting a draft of this arrangement to the president of the University of Illinois, Dean Goss said in part as follows: "The importance of securing proper design and proper methods of manufacture for such wheels may be judged by the fact that there are now in operation in the country approximately 20,000,000 freight car wheels, and the demand for renewals alone involves the manufacture of 2,500,000 chilled iron car wheels per year. With these facts in mind, the Association of Manufacturers of Chilled Iron Wheels has agreed to cooperate with the engineering experiment station in a study of the questions fundamental to the design of such wheel."

*Extracts from the address of President G. W. Lyndon at the annual meeting of the association in New York, October 17, 1916.

PREVENTING HOT BOXES ON THE NEW HAVEN

Fewer hot boxes on the cars of the New York, New Haven & Hartford are being reported than at any time during recent years. During the week ending September 9, there were only 18 hot boxes on passenger cars reported on the entire New Haven road, whereas in the corresponding week last year there were 40 reported. The reduction each week in comparison with the figures for a year ago averages over 50 per cent. The improvement is due in large measure to a more rigid inspection of cars, journals and journal bearings.

The boxes are inspected at all terminals upon arrival of incoming trains and before departure of outgoing trains, special men being appointed for this task. Before use the waste is soaked for 48 hours, and allowed to drain for 48 hours to remove all excess oil. It is packed in the journal box in three distinct parts. The first is a roll which is packed at the back of the box to prevent dust from entering the box from the rear, and to keep the second or center packing in position. This second packing supplies the oil that continually flows between the journal and the bearing. It is placed in the box fairly loosely and on the underside of the journal. The revolving journal draws the oil from the waste upwards, but does not move the waste itself. The third and last part is a roll that is placed in the front of the box to keep the second packing in place and to prevent dust from reaching the journal.

Besides the frequent inspections during the journey of a train, the crew utilizes every opportunity while the train is in motion and at stations, to look to see that no smoke is coming from any of the boxes. Upon arriving at destination, journal boxes are inspected for heated journals and those found unduly warm are marked with chalk as an indication to car repairers that the journal has given trouble and requires attention.

HIGH CONDENSER VACUUM.—Reducing vacuum below 26 in. does not materially increase the efficiency of reciprocating engines, but in turbines there is ample space or passage for large volumes of steam and the lower condenser pressure can be fully utilized.—*Power.*

Car Inspectors' and Foremen's Meeting

The Rules of Interchange Discussed; First Prize Article on Car Department Apprenticeship

THE eighteenth annual convention of the Chief Interchange Car Inspectors' and Car Foremen's Association was held at the Hotel Severin, Indianapolis, Ind., October 3, 4 and 5, President A. Kipp, general car inspector, New York, Ontario & Western, presiding. The meeting was opened with prayer by Rev. Frank S. Wicks, pastor of All-Souls Church. The convention was welcomed to the city by William A. Pickens, corporation counsel of the city, T. J. O'Donnell, of Buffalo, responded to the address of welcome. During the convention the association was addressed by F. W. Brazier, superintendent rolling stock, New York Central East; W. O. Thompson, superintendent rolling stock, New York Central West; A. La Mar, master mechanic, Pennsylvania Lines, and Roy V. Wright, editor, *Railway Mechanical Engineer.*

Corporation Counsel Pickens said in part: I doubt whether the people generally, and especially the traveling public, appreciate the importance of your convention. Those of us who are dependent upon the railways to carry us about the country realize that upon your work depends the safety of our lives. Necessarily you become a set of men who feel the responsibiltiy of your work, and it is well that you hold these conventions to get an interchange of ideas as to how that work may best be performed. No man possesses the wisdom equal to the combined wisdom of his profession and it is to the benefit of the whole country that you hold these conventions and better learn to perform your duties for the advantage of all the traveling public.

A. Kipp, President,
Chief Interchange Car Inspectors' and Car Foremen's Association

PRESIDENT KIPP'S ADDRESS

It gives me great pleasure to welcome the members and their friends to this the eighteenth annual convention of the Chief Interchange Car Inspectors and Car Foremen's Association of America. Our employers, the railroads, which I feel recognize the work that is being accomplished by our association, have made it possible for us to attend and it is sincerely hoped that all will derive profit from the discussions. Principally our meeting is for the purpose of discussing the M. C. B. rules of interchange. We are, however, all familiar with the great problems that are confronting the railroads today and the conditions we will have to face in the future as a result of the stir in certain quarters which without doubt will affect all branches of railroad work. All work must be done thoroughly by each individual as a portion of his effort to assist our employers in solving some of these problems and there is no better way for us to bring this about than to get a clear and concise understanding of the M. C. B. rules and then carry it into practice.

We are all familiar with the equipment in use today, some of it having received betterments in more or less different forms made necessary, in part, by the use of heavier power, but we still have cars that have not been improved and in such cases our inspectors must be very careful in their inspection, using good judgment in order that these cars may be handled safely, without delays, damage to contents or criticism by the operating department. I am aware that in the past year we have been seriously handicapped because of labor conditions and slow delivery of materials and while we are not responsible for this situation it demands concentrated effort and work on the part of all of us. What is needed to alleviate some of the present day problems is a greater uniformity of equipment on our freight cars and while this subject is a general one it deserves considerable thought and should be encouraged. You can draw your own conclusions as to the time and money that would be saved by this practice.

D. R. MacBain, in his presidential address to the Master Car Builders' Association, recommended that that association consider the advisability of making the owners of cars assume all responsibility for the damage and repairs to them. This is an excellent idea, but it involves again the question of equipment of uniform construction, for otherwise it would be necessary for the railroads to carry a larger stock of material in order to make prompt repairs.

The establishment of the office of chief joint car inspector has done a great deal toward improvement in the interchange of cars, and the car inspector himself is a vital factor in the entire plan. Much has been said and written as to the requirements of a good car inspector and much more could be added. In brief, he should be a practical man with a thorough knowledge of car construction, the M. C. B. rules and their proper interpretation, the M. C. B. loading rules, and the safety appliance laws; he should be a man of good judgment and able to apply the knowledge he has obtained in the performance of his work. He should have close relationship with the general inspectors in order that he make make more judicious inspections and better understand the M. C. B. rules.

I am enthusiastic over the good I feel this association has done for the inspector and I wish every inspector could attend our meetings; surely he would go home with an added interest in his work. It behooves each one of us to carry back to our men the ideas and opinions expressed here. The M. C. B. rules of interchange are complicated and require considerable thought and it appears to me that it might be a good plan to have the references and exceptions follow each particular rule, also to combine the M. C. B. rules of interchange, the M. C. B. loading rules and the safety appliance laws, in one book under the heading of the M. C. B. code of rules. By doing this the inspector would be saved a lot of time and would get a better interpretation of the rules.

We have this year broadened the scope of the membership to include car inspectors, M. C. B. bill clerks or anyone actively engaged in the work of the car department. In addition to this the association will consider, for the first time,

other subjects not relating particularly to the M. C. B. rules. This brings the association to the task of studying the car department problem in the larger sense and will make the association of greater service to the roads of the country. A very important subject that should be considered is car lubrication.

ADDRESS OF MR. BRAZIER

F. W. Brazier, superintendent rolling stock, New York Central East, said in part: The Interchange Car Inspectors' the Car Foremen's Association of America was organized for the purpose of obtaining a thorough understanding of the rules of interchange. The association and the men composing it have more to do with the safety of the railroads than any other branch.

W. J. Stoll, Vice-Pres., Chief Interchange Car Inspectors' and Car Foremen's Association

There is no body of men in the country that I take a greater interest in than the young men that are connected with the rolling stock department and who try to help themselves. About 40 years ago I started in as a car repairer and in those days this class of men was very different from the present type. They had to be full fledged carpenters and have a kit of tools. A car repairer also did everything on a car from the trucks up, no laborers being provided.

The car department is recognized on the New York Central as a big, important department. Over $14,000,000 a year is spent in this department on the New York Central proper. However, there does not seem to be the chance for promotion that there is in the locomotive department, from the fact that the motive power department pays a higher rate for its employees and for supervision. This condition is being looked into, I think, very generally over the country, and is arousing a great deal of interest among different officials who realize the power the general foreman or any other foreman of the car department has to spend or save money. In fact, they have their hands on the railroads' pocket books, and I believe that some action should be taken on different roads to make the inducements as attractive in the car department as in any other department. We have many young men who decline to take an apprenticeship in the car department because they find they cannot make the rates of pay that they can in other departments.

At a recent meeting of the Roadmasters' Association the following statement was made: We have made an investigation of 25,550 cases of derailment and the causes were as follows:

Equipment Department	32.5
Operation	51.9
Unavoidable	11.4
Maintenance	4.2

The point I want to convey to you is the importance of inspection. You have this in your own hands better than any organization there is in the railroad service, and you should keep before your officials the importance of closer inspection of the equipment. We overlook many of the little things which lead to derailment. Among them are the absence of spring cotters in brake hanger bolts and brake connections which cause the brake hanger pins or brake beams to drop to the rail and cause derailment. There is no need of putting a nail in place of a spring cotter. If you will look into the percentage of derailments caused by brake beam failures you will be greatly surprised. Consequently there is no subject that you can take up that will result in more good to the railroads than better maintenance of equipment. As I stated at the M. C. B. convention, on all bolts in trucks and brake connections there should be some approved kind of nut lock or spring cotter so that the bolts and brake pins cannot get out of place.

I recently attended a "Giant" ball game. I watched that wonderful infield and the secret of the success was that they pulled together. It is just so in railroad work; we are made up of different departments, the car department is only one of the large number, but we have all got to work together to bring about the right co-operation. You know when a car inspector decides that a car is unsafe to move, no official would dare to run it. Consequently it is up to you gentlemen to keep before your officials the importance of the little things that should be maintained on cars to save derailments and save delays of holding up the cars for extensive repairs.

In closing I want to say one thing more about your convention and what your discussions will mean. Your interpretation of the rules, coming as you do from the North, South, East and West, will be the means of your having a better understanding of the rules, so there will be less friction and a better movement of the freight, which at the present time, with the terminal facilities we have, is exceedingly important.

ADDRESS OF MR. THOMPSON

W. O. Thompson, superintendent rolling stock, New York Central West, said in part: I never had the pleasure of attending one of your meetings before, but have heard a good deal about them and have always been very much interested, to the extent that I send, I believe, as many representatives as any other road in the country and I find that allowing our representatives to be here proves a good investment for the company. The car department of the roalroads has improved wonderfully during the past few years, to the extent, at least, that railroads all over the country are very rapidly recognizing the fact that a big leak in their expenditures is through the manner in which their car departments have been handled in the past. I have found that more money can be saved or thrown away (and no one any the wiser for it) in the car department than any other department on the road.

W. R. McMunn, Secy.-Treas., Chief Interchange Car Inspectors' and Car Foremen's Association

Mr. Brazier, in his remarks, has said that this association is one of the most important in the country. By getting together and going over the Rules of Interchange thoroughly, you come to an understanding between yourselves in the interpretation of the rules. This means, that instead of holding up cars all over the United States on account of differences of opinion among different inspectors, the rules are understood alike and the cars are kept moving, and particularly at this time your understanding of the rules pays many, many times over the cost of sending you to this convention. I firmly believe that every railroad in the United States, Canada or Mexico cannot do better than to send a sufficient number of representatives to each one of your conventions and pay their

expenses for the good that the roads themselves will derive from it.

ADDRESS OF MR. WRIGHT

There is one thing that those of us who are on the outside have come to appreciate greatly in recent years and that is the tremendous possibilities in the car department. The mechanical department has been very largely dominated by men who have come up through the locomotive department. Car department men have not always gotten their just deserts. Railway executives and those who are spending the money have come to realize that the car department is spending a tremendous amount and that it is vitally important to have big men—men of executive ability and men of business ability—to administer the work of that department. Car department men, realizing their responsibilities, are coming to assert themselves.

One great trouble with both our industrial concerns and our railroads has been that too little attention has been given to getting the right kind of young men into the ranks in order to carry on the work in the future. Last week there was a paper read before the Railway Club of Pittsburgh by George M. Basford, a great friend and source of inspiration to young men, in which he called attention to the big problems affecting the locomotive and its operation which must be solved; his idea was that here was a great opportunity for young men. As I listened to him the thought came to me that there were just as big problems to be solved in our car departments, possibly bigger ones, more efficient interchange methods, better maintenance to get full service value out of the cars, improved repair and inspection methods, better design, better practices in selecting and training men in order to increase the efficiency of the human element, and the building up of a wide-awake, enthusiastic organization are a few of the problems you are up against. Competition with industries has made your labor situation a most serious one. It requires real men to overcome these conditions. It is your opportunity.

There is another thing that has occurred to me as I have listened to your discussions, and that is the criticism of the mechanical engineers because they have designed cars and equipment which do not give the best results, that they have overlooked the practical difficulties that the car department men are up against. I wonder if we are right in charging that entirely to the mechanical engineer. If the car department men do not make a big enough noise to impress the mechanical engineer and those in charge of the designing of equipment, isn't it the fault of the car department? You have simply got to go after them until you can get them to see their mistakes and make them come to your way of thinking. I submit that you fellows who are right on the firing line ought to go to the mechanical engineer and keep after him until you get things right. There are greater possibilities in improving the design of our cars than we ever thought of in improving the design of the locomotive.

The solution of the car department problems and your future success is going to depend almost entirely upon what you do in selecting and training men to carry on the work of the car department. Too little attention has been given to that feature. The *Railway Mechanical Engineer* had a competition a year ago for the best articles on the qualifications and training of the car inspector. This competition brought out this truth—that too many roads were selecting their car inspectors almost as they can grab them at random. I honestly believe that unless we give the attention that we should to this matter of selecting the young men and training them specially for the car department that we will find ourselves in a serious predicament in the years to come.

DISCUSSION OF INTERCHANGE RULES

The discussion of the rules was confined largely to those which have been changed within the past year.

RULE 2, SECTION (b)

Cars loaded with explosives must be handled in accordance with the regulations of the Interstate Commerce Commission. Cars containing inflammable liquid which is leaking must be repaired or transferred without any unnecessary movement or at nearest available point.

T. J. O'Donnell (Buffalo): I would like to ask the interchange inspectors if, when they find a tank car leaking in the receiving yard where the inspection is made, they always insist upon the nearest repair point disposing of the load. Would gasoline be considered the same as fuel oil, or anything that is slow combustion?

G. Lynch (Cleveland): Where a car is leaking gasoline or any highly inflammable materials, it would be returned to the delivering line. If it is ordinary materials that are leaking we send it on to the receiving company's shop, or agent, for the necessary attention.

Mr. O'Donnell: My point was: Should the nearest repair point be the place to which the car is to be taken for repairs? The rules say "the nearest repair track."

Mr. Lynch: When a car is leaking, whether tank or box car, we have to dispose of it in accordance with local conditions. We try to save the return movement of the car as much as possible.

F. C. Schultz (Chicago): I fail to find a rule by which you can compel the receiving line to accept cars containing inflammable materials if delivered in a leaky condition. We ask the receiving line to carry out the intent of the M. C. B. rules.

Mr. O'Donnell: We force the receiving line to take leaking tank cars provided they have the nearest repair point, and the executive committee has upheld us, saying that it is a rule of the M. C. B. Association and that the car must be handled at the nearest point.

J. C. Keene (Wabash): At St. Louis we have a local arrangement whereby the cars must be inspected before delivery, but if found on the interchange track leaking, it is up to the receiving line to take steps to transfer the car, if necessary, and any extra expense is charged to the delivering line.

H. Boutet (Cincinnati): The rule says "the nearest available point." We try to transfer or repair the car with the least possible handling.

F. H. Hanson (N. Y. C. West): It is my understanding of the rule, that if cars are found in a defective condition and the delivering line's repair track is half a mile from the interchange point, and the receiving line's repair track is three miles away, according to these rules, the delivering line should repair the car because it would only be necessary to handle it a half mile as against three miles. It is always customary to have all cars go forward, but in accordance with this rule, we should give the car the necessary attention at the nearest available repair point. I move, therefore, that it is the understanding of this meeting that that portion of Rule 2 means that the car must be repaired at the nearest available repair point, regardless of whether it is the receiving or delivering line's.

Mr. Lynch: I agree with Mr. Schultz that you cannot compel the receiving line to take a leaking tank car with gasoline or anything of that kind unless it be released from loss and damage. We have had some China oil shipped in box cars. It is very penetrating and sometimes the barrels leak very badly. In one case when the cars were offered to a connecting line they were taken and the loss and work done to the barrels to put them in forwarding condition was reported to the delivering line which refused to release the receiving line from responsibility for this loss and damage. The delivering line took the stand before the committee and was beaten. The committee upheld the receiving line in its stand that it was not obliged to take the cars unless the delivering line gave it a release.

Mr. O'Donnell: We are supposed to uphold these rules. I would not have any hesitancy in telling the delivering line

"It is your load," and let the officials fight it out afterward. The foundation of our agreement is to expedite the movement of cars.

M. H. Halbert (St. Louis): Mr. O'Donnell has expressed my views. In the St. Louis territory we have such cars repaired by the receiving line in a good many cases. Whenever we can, we keep the commodity moving in the direction it is billed.

N. B. Elliott (St. L. & S. F.): You will find that 50 per cent of the tank cars you transfer are not leaking at all. They are just seeping.

Mr. Hanson's motion was then put to a vote and carried.

RULE 2, SECTION (f), PAR. 3

All other truck defects on foreign cars, except metal bolsters, center plates where cast integral with bolsters, metal truck sides, metal truck transoms and metal spring planks; also excepting non-M. C. B. standard journal boxes and contained parts in cases where the M. C. B. standard is not a proper substitute.

W. M. House (So. Ry.): The rule says all other truck defects on foreign cars. What do we term a defect? Is a solid pedestal truck that is cracked one inch or 1½ in. considered a defect? Or are we going to be permitted to run the car and load, with safety. Or are we to get a transfer order for such cars?

President Kipp: The chair decides that the receiving line would be the judge as to whether it would be a defect that was safe to run.

Mr. House: The chief joint inspector will say that the car is safe to run. The truck frame is not broken; it is cracked. We know that a crack in a solid pedestal truck is not going to get better.

Mr. O'Donnell: Where the crack runs into the web it is dangerous. Where it is only in a half inch, if the load is in first class condition, we take a chance on it, but the receiving line is the judge. It is up to the delivering line to give protection.

RULE 2, SECTION (f), PAR. 6

Renewal of roof boards of outside wooden roofs, and of inside metal roofs, where such renewal does not exceed 25 per cent of the roof boards, and where purlines, rafters, ridge pole, side and end plates are in good condition, on all cars.

A. Armstrong (Atlanta): What reference is there in the rule to the condition of the metal roof? If there are ten sheets of inside metal roof missing, which would be within the 25 per cent, and not covered by the 25 per cent of the outside roof, does it mean that you can renew one or both?

J. J. Gainey (C. N. O. & T. P.): The rule is plain. It says if there is any part of the inside roof gone you are entitled to a transfer. It does not refer to the metal roof at all. It refers to the double board roof, or roof boards over a metal roof. It does not pertain to the metal roof.

H. Boutet (Cincinnati): I move that the interpretation of the rule be as given by Mr. Gainey. (The motion was carried).

RULE 2, SECTION (j)

When load is not transferred, the car, if foreign, may be returned, when empty, to the delivering line, properly side-carded on both sides of car with a bad order return when empty card, showing the defects for which the car is returned, in which case it must be accepted. For card see page 229.

F. C. Schultz (Chicago): Some people are under the impression that they can run a car all over the line, reload it and then return it after applying "bad order" cards.

Voice: You interpret it as a switch car on that company's line?

Mr. Schultz: Exactly.

G. Lynch (Cleveland): I interpret it the same as Mr. Schultz. There is a question and answer at the bottom of page 5 in the Rules which explains it clearly.

Mr. Schultz: Under a local agreement if a car is away 60 days and requires such repairs, we require the delivering line to make them.

Mr. Lynch: There is no limit to that as far as Cleveland is concerned.

S. Skidmore (C. C. C. & St. L.): The Arbitration Committee has disposed of that question by an interpretation as follows: "Your committee feels that such a foreign car moving on its home route empty must be accepted, if in the same physical condition that it was when forwarded under load."

Mr. Schultz: We should take some steps at this time to interpret the rules uniformly. The large interchange points should get together, have the interchange committee work out a rule that will be universally endorsed.

H. Boutet (Cincinnati): As far as Cincinnati is concerned, we work exactly as Mr. Lynch does. If a car comes back in the same conndition in which it was delivered, it is accepted.

Mr. Schultz: I do not believe that at large terminals a car which is empty, moving in its right direction, should be set back for any condition, for the reason that if it is set back it has to move back through the same channel

M. H. Halbert (St. Louis): We have no rules in St. Louis under which the delivering line is held responsible for the condition of, and the returning of, an empty car, providing the defects under Rule 120 do not exist. If a car is safe to handle the load, we will accept it on its return or empty movement, even though it has defects other than those with which it was received. Any car that originates on the line, we handle just the same as if it were a foreign car; when it is returned to the delivering line or the originating line, it will take care of all car owner defects and delivering line defects, as far as cardable defects are concerned. When the defects come under Rule 120, we hold the delivering line responsible for the disposition of the car. However, we will card all cardable defects to the originating line. The originating line must take care of all car owner defects. If one line delivers a car to another line with defects that should be repaired before it is safe to take to its destination, on the return of that car, even though it is in a worse condition, we have the delivering line take care of the repairs.

J. J. Gainey (C. N. O. & T. P.): Recommendation along the line of the argument of Mr. Schultz and Mr. Halbert was put to the Arbitration Committee and it disapproved it.

Mr. Halbert: I do not think they looked into it far enough. We have the biggest interchange point in the United States and if the committee will stop and consider the way we get traffic through the gateway of St. Louis, it will come to it. Take care of the other fellow's car when it originates on your line and help it through.

Mr. Gainey: The arbitration committee says "Not approved. The object of the present rule is to obtain better maintenance of foreign cars away from home, and it is believed that the proposed change would have no other effect than to defeat this object."

President Kipp: In view of the decision of the Arbitration Committee, St. Louis seems to be operating contrary to the spirit of the rules and should take such measures as may be necessary to have the practice changed.

RULE 3, SECTION (c)

Cars built after October 1, 1914, and prior to January 1, 1917, will not be accepted in interchange unless equipped with either the No. 1 or the No. 2 M. C. B. standard brake beam, as indicated by the light weight of the car. Cars built after January 1, 1917, must be equipped with metal brake beams of not less than the capacity of the No. 2 M. C. B. standard, or stronger, as the conditions may require. All of the brake beams referred to shall have the letters "M. C. B." and proper number plainly stamped or cast on strut, as required by the specifications. After October 1, 1918, cars will not be accepted in interchange unless equipped with all-metal brake beams.

E. Pendleton (Peoria): Tell us what a No. 1 and No. 2 brake beam should be applied to.

W. R. McMunn (N. Y. C.): A car weighing over 35,000 lb. should have a No. 2 beam; under 35,000 lb. it may have a No. 1 beam.

F. H. Hanson (N. Y. C. West): How is an inspector going to tell whether a beam is stamped No. 1 or No. 2?

President Kipp: A man cannot find out without the liability of getting his head cut off.

H. H. Harvey (C. B. & Q.) I think that Mr. Hanson is entirely right and that it is up to this association to make a recommendation to the M. C. B. Committee on Standards, or the Brake Beam Committee, or the Arbitration Committee, that brake beams must be marked on the brake head and not on the brake strut.

Mr. O'Donnell: It has been brought to the attention of the M. C. B. Association and it appreciates the fact and is, I understand, going to correct it.

Mr. Pendleton: There is another thing that should be called to its attention and that is the stenciling of cars equipped with metal brake beams. Cars should be marked showing type or number of the beam standard.

RULE 3, SECTION (e)

Tank cars (empty or loaded) will not be accepted in interchange unless they comply with the M. C. B. Tank Car Specifications.

Note.—It will be understood that all tank cars carrying safety valves must have the valves tested and the tanks tested and stenciled, as required by the specifications, regardless of the commodity carried in the car. Tanks only shall be stenciled to show tests of valves and tanks.

Mr. Skidmore: There has been some discussion here about the stamping of safety valves on tank cars and whether or not it is still a requirement of the rules. My understanding is that a valve requires stamping just the same as heretofore. If the stenciling on the tank is obliterated we still have the stamp on valve to go by.

Mr. Gainey: The present specifications require that the record of test of safety valve shall be stamped on the body of the valve in addition to being stamped on the tank.

F. W. Trapnell (Kansas City): The M. C. B. Association knows something of the difficulties under which the inspectors labor, when tanks are loaded, to get the desired information from the safety valve and they have made a provision in the rules whereby, if the tank is properly stenciled, the inspector does not have to bother to inspect the valve, and I move that that interpretation is the sense of this body.

The motion was carried.

RULE 4, PAR. 2

Defect cards shall not be required for any damage that is so slight that no repairs are necessary.

J. C. Keene (Wabash): The lack of a uniform interpretation of this paragraph is one of the most serious problems we have to deal with today, and one that is causing a great deal of unnecessary correspondence and trouble. This rule specifies that defect cards shall not be required for defects so slight that no repairs are necessary, but renders no interpretation of what is to be or shall be considered necessary repairs. I would say repairs should be made at the time of interchange or no defect cards be issued. Certainly if a car with a raked siding or roofing is safe to carry its load to its destination without damage to the contents of the car no repairs would be necessary. Bent parts on metal cars not requiring immediate shopping rarely weaken the construction and are seldom repaired until the cars are placed in the shops for rebuilding or reinforcing. This is proved by the fact that defect cards in a great many cases are not used for two or even three years after date of issuance, a practice which in my opinion is wrong.

The Master Car Builders' arbitration committee has ruled that where defects are passed as not necessary to card, and later carded at another interchange point, no rebuttal cards should be issued. Consequently to avoid further complaint and criticism the inspector tightens up on his carding, issuing defect cards to please the fellow at the other end of the line and not in accordance with his own judgment. In order to overcome this condition and reduce the carding to what it should be, some points have adopted local agreements to protect the inspector furnishing defect card on the record if carded at another point, but I feel the difficulty would best be remedied by a universal understanding or interpretation of this rule.

F. W. Trapnell (Kansas City): Defect cards should be applied under the supervision of a chief interchange inspector, who would see that the rules are properly complied with and that no card is issued unless the car owner is justly entitled to it and stop the present practice of the great abuse of the defect card. The second paragraph of the rule should be changed to read "No defect card to be issued by inspector in connection for any damage which does not require immediate repairs." In the third paragraph the rules state that "At outlying points where joint inspection is not in effect the matter be left to the judgment of the receiving line." This is costing the railroads large sums of money, as the inspectors demand defect cards for damage so slight that it is scarcely visible, and without the proper supervision this practice will still be continued. I have taken defect cards off cars where the siding has been marked by a nail or some one holding a piece of wood against the side of car when moving and which had not raked through the paint, and in some instances the inspector has carded for one-half of the siding on one side of the car. Others demand defect cards for owner's defects such as end sheathing broken out (new defect), old air date, draft timber bolts and lug bolt broken (old defect), paint scorched on five side planks A & B ends, pitch only drawn out by sun, and other cards for damage too slight to mention. If the owner gets the card it can bill the line whose defect card is on the car for the total amount covered by the defect card, as per Arbitration Cases Nos. 319, 397 and 399, which rule that the ignorance of the one applying the defect card is no excuse, and it must carry with it the admission of the delivering line's liability.

The judgment of the inspectors are at variance, some using good judgment; others, equally as good inspectors, are not allowed to use any judgment, but card for everything possible according to instructions. Some of these cards remain on cars four and five years and as no repairs were necessary at the time the card was issued no bill should be made.

Again cars are passed by an inspector at one interchange point and carded by another inspector at the next point, resulting in the first inspector being severely criticized for not applying a defect card for defects which in his opinion required no repairs. Consequently he tightens up on his interchange inspection and gives his company the benefit of any doubt, which results in the application of defect cards for technicalities, setting a bad example for other inspectors.

F. C. Schultz (Chicago): A cardable defect ought to be a defect which required repairs before the car could be handled, and this should apply to foreign as well as to home cars. I am well satisfied in my own mind that at least 75 per cent of the defects on cars that are being carded are defects which could safely be allowed to exist, and are allowed to exist, until at some future time the car is placed in the shop for an entirely different reason. The present system is wrong.

T. J. O'Donnell (Buffalo): Many officials issue instructions to their foremen to get down closer on the carding. The result is that the stubs begin to come in to our department 50 per cent heavier. I took it up with some of our officials who issued such cards and they said: "We are willing to waive these instructions if you can get the other points to let up." Why should such orders be issued promiscuously in the yards? It would be better to have a conference and ask those issuing such instructions if they feel that they are observing the M. C. B. Rules, or whether they are allowing cars to get away from the district that should be protected. You can easily get a medium of decency. I think the inspectors are using their very best judgment under the conditions.

G. Lynch (Cleveland): Some of the car inspectors are

directly under the supervision of the chief joint inspector and others under the supervision of the local foremen of the receiving lines; if the latter, you can never get uniformity. Where you have as many different foremen as you have at the local points, you will have just as many different instructions. Your inspectors will never use their own judgment but will want to protect themselves and thus issue defect cards indiscriminately.

H. J. Smith (D. L. & W.): The solution for a great part of the difficulty would be to place a time limit for billing on defect cards.

Mr. Schultz: Only about 40 per cent of the defect cards are billed on. That is the best evidence, at least, that many are issued for defects that should not be carded. A proper interpretation of this rule is the solution of the whole situation. You cannot go before anybody and stop them issuing defect cards. The suggestion made by Mr. Keene is none too broad: We would make this read: "Defect cards should not be required for any damage that is so slight that immediate repairs are not necessary."

W. K. Carr (N. & W.): There are cars that go around two or three years with defect cards on. Ten or fifteen years ago we had a six months' limit on a defect card. Why not put that limit on today and if repairs are not made within that time, it is lost.

H. H. Harvey (C. B. & Q.): I had occasion to check up the defect cards that were issued against our road for a period of six months. I found 51 per cent of the cards that were issued, either by the Burlington or by other roads against the Burlington, had not been billed on. That is pretty good evidence, to my mind, that there is not so much dishonesty in billing on defect cards as some would lead us to believe. I agree with everything that has been said about issuing defect cards. And I hope the time will come when there is no such thing as a defect card. It may be a raked side sheathing but it is a delivering line defect and the inspector wants a card and I do not see how you are going to get away from permitting him to have a card under the present M. C. B. Rules.

S. Skidmore (C. C. C. & St. L.): There are a number of lines receiving loaded cars with defects which do not require immediate repairs because of the fact that the cars are loaded and can be allowed to go to their destination. The car comes back to the owner and the inspector concludes that the car requires immediate attention because they can get a defect card against the delivering line. It is marked "repair track" and they get a defect card. According to the argument here that would be just and equitable. They pass these cars through from the West, or the East, loaded. They are good enough to pass them along, and when they come back empty the car inspector jumps on them and gives a defect card against the delivering line for the defect. Why? Because they can get a defect card where it requires immediate repairs and you cannot dispute them on it. Why should not the car be carded when it leaves the line.

Mr. Trapnell: I move you that the chair appoint a committee to bring in a report on a proper interpretation of the second paragraph of Rule 4. Mr. Trapnell's motion was seconded.

Mr. Lynch: In line with Mr. Skidmore's remarks, I find it necessary in cases of cars loaded with perishable freight where they have been badly wrecked or cornered to make temporary repairs and cover the damaged part with rough boards. It is necessary to card such cars that can be repaired when empty.

Mr. O'Donnell: I really think the trouble is not the fault of the supervision. It is the feeling of fear that cars passing between roads will be carded against them. The inspector should know when to put a card on a car. You can look at it and in an instant you can say: "If I had to pay for these repairs out of my pocket, I would not pay it." Why not say the same thing for the delivering line. We are working for the railroads; let's be decent with them.

M. H. Halbert (St. Louis): We handle interchange perhaps a little differently from any interchange point in the country. The receiving inspector does not issue M. C. B. defect cards for defects on empty cars that do not require repairs. Should the car be defect carded it is sent to the repair track to be handled with the foreman of the receiving line. If he cuts out a loaded car or puts a card on a car for cardable defects, the original stub is turned into my office and I make it my business, when I find a stub that does not look right, to make an investigation. There is no foreman in our territory who can tell me what to card and what not to card. He is under my jurisdiction and if he cards right I will back him up, but if he cards wrong, I do not.

Mr. Trapnell's motion was put and carried.

The report of the committee follows:

"Your committee appointed to take up and report specially on the second clause of Rule 4, in so far as the use of defect cards are concerned for damages too slight to warrant repairs, respectfully submits the following:

"*First:* This rule was incorporated by the Master Car Builders' Association to overcome the abuse of defect cards in interchange and has been in the rules for a number of years and your committee at the outset feels that we should respect and live up to and follow the strict intent of this rule.

"*Second:* The rule provides that the chief joint interchange inspector is the judge for carrying out the intent of this rule and it is felt by your committee that in many cases it is merely nominal and not positive and if arrangements could be made that the intent and purpose of this rule could be absolutely covered by the chief joint interchange inspector and any local changes desired by roads bearing on the same must be handled through the chief joint interchange inspector and his decision be final in all cases.

"*Third:* In submitting this recommendation, it is given with the full intent and understanding that all members of this association will use their personal and best efforts to correct this evil, as we feel it can only be corrected by the hearty co-operation of the different interchange points, which is submitted with the understanding that it is acceptable."

The report was signed by: T. J. O'Donnell (Buffalo), F. C. Schultz (Chicago), S. Skidmore (C. C. C. & St. L.), H. H. Harvey (C. B. & Q.), W. M. House (So. Ry.), F. W. Trapnell (Kansas City), J. J. Gainey (C. N. O. & T. P.), J. P. Carney (M. C.), and H. J. Smith (D. L. & W.).

RULE 4, PAR. 4

Defect cards shall not be required for missing material in fair usage from cars offered in interchange. Neither shall they be required of the delivering company for improper repairs that were not made by it, with the exception of the cases provided for in Rules 56, 57 and 70.

W. K. Carr (N. & W.): There seems to be a difference of opinion in regard to defect cards. The difference is on the question of what constitutes fair usage. For instance, take a gondola that has 50-in. steel sides with four 5/8-in. by 2 1/2-in. cross pieces at the top, which comes down on the outside and is secured with an inch rivet. When that brace is missing it is considered fair usage at some points and at others it is unfair usage. Which is correct?

President Kipp: The Arbitration Committee has decided that angle bars and cross tie rods are at owner's risk and I assume that this is along that line.

Mr. Carr: That is a concealed part.

President Kipp: It may be observed by an exterior inspection.

Mr. Carr: You can see the brace under all conditions and it cannot be removed under fair usage.

W. J. Babcock (D. & H.): The company for which I work has the same trouble and I have the decision to which Mr. Kipp refers. The decision as I see it, refers to tem-

porary transverse tie rod and not permanent transverse tie rods and angles with which the cars are originally built and designed. These cross tie angle rods are visible from the outside. The rod goes through the car and there are nuts on the outside of each side of the car. It is a well known fact that 90 per cent of these cross tie angle bars are removed by shippers to facilitate the loading and unloading of cars, with clam-shells, etc., and I cannot see where that is an owner's defect when they are removed by the shipper. It is not fair usage to remove these and leave them out and compel the owner to put them back again. It would appear that it is the duty of the delivering line to compel the shipper to put them back.

Mr. Carr: Those rods and these cross rods I refer to are not comparable. The braces we put on are riveted. They are permanent fixtures and if you remove them you have destroyed the construction of the car.

J. H. Weal (N. Y. C.): I think Rule 21 paragraph B clears the thing up.

C. R. Dobson (C. R. I. & P.): I think Rule 43 covers that.

F. H. Hanson (N. Y. C.): I believe that the car was constructed wrong. A man has a perfect right to cut these rods out in order to load lumber. I believe that a car in that condition should be an owner's defect.

Mr. O'Donnell: When you build a car it is supposed to have the approval of the American Railway Association, unless you stencil the car to show that it should not be loaded with such commodities.

Mr. Carr: The car is strictly a coal car.

RULE 9

W. J. Babcock (D. & H.): If you apply a Westinghouse triple made by the New York Air Brake Company and stamped "New York," what would you show as the type?

Answer: We would show Westinghouse triple valve.

F. H. Hanson (N. Y. C., West): Is it necessary to sign joint evidence card for an H-1 New York triple when applied in place of a K-2 Westinghouse? There is a difference in the price.

President Kipp: The chair would say that it would not be permissible to apply an H-1 valve in place of a K-2; in other words, it would be wrong repairs.

Mr. Babcock: I take it these two triples do not perform the same function. One has a retarding device and the other has not. They are not of similar type. You can exchange a New York triple in place of a Westinghouse if it is the same type—if it performs identically the same function; otherwise you make wrong repairs. The prices of the two triple valves of similar type are the same.

RULE 33

Owners will not be responsible for the expense of repairing or replacing ladders, handholds, sill steps or brake shafts, whether or not in connection with other repairs

F. H. Hanson (N. Y. C., West): If we get a car equipped with U. S. safety appliances and it is equipped with a hand hold which does not meet the requirements, can you change this and bill the car owner for the expense? A great many roads are doing it.

N. B. Elliott (St. L. & S. F.): We have been doing that right along, and render bill.

Question: How about cars not equipped with the U. S. safety appliances?

Mr. Hanson: That is an owner's expense. We write the owner and there are no questions asked whatever if we equip the car with safety appliances. But the part I refer to is, are we justified by a strict application of Rule 33 in billing the car owner for the change of any of these parts? Our billing department has advised me that there has not been a single case where the owners would not accept bill.

President Kipp: The rule is very plain. The chair would decide that you cannot bill the owner of the car for any of these items without authority to do so.

W. R. McMunn (N. Y. C.): As I understand this proposition, all cars built on and after July 1, 1911, must have been equipped with the U. S. safety appliances standards. Any car built prior to July 1, 1911, must after a certain date be equipped with U. S. safety appliances. At the present time it is a violation of the law to accept a car built after July 1, 1911, unless it meets the requirements of the U. S. safety appliance law in every detail. Cars built prior to July 1, 1911, may be equipped with U. S. safety appliances. When you once accept a car you assume responsibility for it and any repairs that may be necessary to safety appliances, must be assumed by the handling line.

E. Pendleton (Peoria): It seems to me that under the interpretations given on page 63 it is a handling company's defect, and I would move that that be the interpretation of this body.

The motion was carried.

RULE 36, SECTION 3

Special Placards.—These shall be such as are required by the "Interstate Commerce Commission Regulations for the Transportation of Explosives and other dangerous articles by freight and by express," and are to be of the size as therein described. They shall be used, be of the text and be attached to the cars as prescribed by said regulations.

A. Armstrong (Atlanta): If a car bearing these placards has been made empty and returned to your line, may you remove them and bill the delivering line the same as an advertisement?

Mr. Schultz: The American Railway Association recommended to the M. C. B. Association that this be made a penalty. I think the M. C. B. Association did not agree with it, and since it did not see fit to include it in the rules it is not a cardable defect.

RULE 43

Owners Responsible.—Any damage to all-steel or steel-underframe cars, unless such damage occurred in wreck, derailment, cornering or sideswiping, and except unconcealed fire damage.

G. Lynch (Cleveland): In view of the recent decision of the Arbitration Committee that drop doors on steel cars cannot be lost in fair usage and that, therefore, the delivering line is responsible, I want to ask the chief joint inspectors present if, when steel cars with doors, drop or hopper, are offered in interchange with one or more missing, is it a cardable defect? Does this decision make the delivering line responsible for missing doors of gondola cars?

President Kipp: I would say that the decision is final and binding. A door found missing under the conditions described by the Arbitration Committee decision would be a cardable defect in interchanges.

Mr. Lynch: In loading ore on the hoppers, the weight will carry the door away because of the mechanism of the door, or the parts securing the door. The loader permits the car to be loaded to capacity. We sometimes find the same thing in loading stone. It is not uncommon to find a door or two missing on these cars and the car is loaded. Are we going to make the delivering line responsible?

A. M. Patrick (Mechanicsville, N. Y.): Issue a defect card. It is a cardable defect.

H. Boutet (Cincinnati): I believe a majority of the interchange inspectors understand Rule 43 to mean that it is an owner's defect unless there was evidence of unfair usage.

Mr. Trapnell: The Arbitration Committee has laid down this emphatic rule for us to work by, and they have not told us we could use our judgment in the matter unless certain things have occurred to the car. If certain things have occurred, then we can card; otherwise we cannot.

Mr. Pendleton: Perhaps the Arbitration Committee had some information which guided it in the decision that we do not know anything about, but the fact remains, as we understand the rule, and as it has been interpreted to us by the

Arbitration Committee, that without evidence of unfair usage, the damage should be charged to the car owner and we should decline to card.

RULE 58

Delivering Company Responsible.—Air brake hose, when missing complete, missing cylinders, reservoirs, triple valves, interior parts of triple valves, angle cocks, cut-out cocks, dirt collectors, pressure-retaining valves, release valves, pipe or pipe fittings; also damage to any of these parts when such damage is due to wreck, derailment, cornering or sideswiping.

G. Lynch (Cleveland): Is an angle cock handle broken an owner's defect? As I understand it, if there is no evidence of unfair usage, the owner is responsible.

T. J. O'Donnell (Buffalo): The usual way of breaking the handle is by the trainmen hitting it with a hammer. It should be delivering line defect.

J. V. Berg (N. Y. C., West): A broken angle cock is owner's defect according to the rule.

F. H. Hanson (N. Y. C.): I move that it is the sense of this association that it is an owner's defect.

The motion was carried.

RULE 86

T. E. Giblin (C. & A.): The size of the journal is not quite clear. On the 80,000 lb. capacity cars it says—4½ in. journal; 6¼ in. wheel seat and a 5 5/16 in. axle center, which is 1/16 in. larger than the M. C. B. standard. The other measurements are M. C. B. standard. A non-M. C. B. axle of the 80,000 lb. capacity measures the same as M. C. B. with the exception of the axle center which is 1/16 in. larger than the M. C. B. standard.

Mr. Pendleton: While the axle center is 1/16 in. greater than the M. C. B. standard, it applies to the M. C. B. standard axle. I cannot understand it in any other way than if you maintain a non-M. C. B. axle, it must not be less than these measurements.

H. Cockran (B. & O.): An axle removed for any cause whatever must be less than the prescribed limits. Suppose it reaches those limits but does not go below; is it a scrap axle?

Voice: It says below the prescribed limits.

Mr. Hanson: I have never heard of an 80,000 lb. non-M. C. B. standard axle and believe the dimensions shown are in error, particularly as to wheel seat.

C. J. Hayes (N. Y. C.): I believe the measurements given on page 108 for 80,000 lb. and 100,000 lb. capacity axles are 1/8 in. less than the M. C. B. dimensions. It came out in a circular under the 1915 rules that there should be a variation allowed for rough turning; on the 100,000 lb. and 80,000 lb. capacity cars 1/8 in. should be allowed, and on the 60,000 lb., 1/16 in. should be allowed. These dimensions have been reduced to conform to the allowances the committee gave.

Voice: They do not make any allowance on the non-M. C. B. standard.

Answer: They ruled that sufficient allowance was made on the non-M. C. B. axle.

RULE 98

S. Hansen (P. & P. U.): Is there any overlapping labor charge in changing two pair of wheels in the same truck?

F. C. Schultz (Chicago): It seems reasonable if you remove two pair of wheels on the same truck there should be some credit as it reduces the amount of work considerably for the second pair. The foot note seems to be an explanation.

C. J. Hayes (N. Y. C.): A reduction of 28 cents ought to be made when two pair of wheels are removed from each truck. If you had a pair of wheels on A end and a pair on B end of the car, no reduction would be made.

RULE 99, PAR. 2

When axle is removed on account of owner's defects on wheel, and the journal has increased in length more than 3/8 in. or the collar is worn to less than 5/16 in., or the diameter of the journal is not at least 1/8 in. greater than the limiting diameters given in Rule 86, the axle shall be considered as scrap and credit allowed accordingly.

C. J. Hayes (N. Y. C.): Referring to the second paragraph, I move that it is the understanding of this association that when the axle removed does not come up to the requirements in regard to dimensions; it should be scrapped against the owner.

The motion was carried.

RULE 102, PAR. 3

In computing charges for bolts, nuts and forgings, if fractional weight of each entry on billing repair card is less than one-half pound, it must be dropped; if one-half pound or more, charge the entire pound.

W. J. Babcock (D. & H.): If the weight of the bolts or nuts applied is less than ½ lb. you would drop it. If in making heavy repairs and the number of different sized nuts were under a half a pound, would you take the aggregate weight and in that way secure what you are entitled to?

J. C. Keene (Wabash): If less than a half a pound, you should forget it, but you are permitted labor in all cases.

Mr. Hayes: You cannot take the nuts or small bolts in the aggregate. We have to make the extensions under each item and if less than ½ lb., you would then drop it.

Mr. Schultz: That does not seem right. You are liable to lose two or three pounds on one job. You can only drop the fraction of the pound in closing up your total weights.

Voice: It says each entry. It does not say the aggregate.

F. W. Trapnell (Kansas City): I move that this be sent to the Arbitration Committee for interpretation.

Mr. Babcock: Before this rule was put into effect, the road which I represent had an agreement with several of our connections to try it out. We took several large bills against us that amounted to $400 or $500 from four different roads. We figured out all the nut charges on the actual basis of the overcharges and the undercharges and in no case did it amount to over $2.00 in a $600 bill, either one way or the other.

The motion to refer the rule to the Arbitration Committee was carried.

PASSENGER CAR RULES

F. W. Trapnell (Kansas City): The preface of these rules makes damage occurring in ordinary service, etc., car owner's responsibility. During the movement of troops, and, also, with a great number of tourist cars in interchange, we find many cars running with broken window glass and broken vestibule door glass. There is no indication on the car that it has received unfair usage. Would that be owner's or delivery line's responsibility?

W. R. McMunn (N. Y. C.): It will be admitted that the intent of the rule at the present time is that damage to any part of a car which can be seen without entering it, is considered delivering line responsibility, but that any defect which cannot be seen without entering car would be considered owner's responsibility. The inside parts would be considered owner's responsibility. My judgment is that broken window glass would be delivering company's responsibility.

APPRENTICESHIP COMPETITION

The following awards were made in the competition for the best article on car department apprenticeship: First prize of $25 to B. F. Patram, foreman car repairs, Southern Railway, South Richmond, Va.; second prize, C. N. Swanson, superintendent of car shops, Atchison, Topeka & Santa Fe, Topeka, Kan.; third prize, W. K. Carr, chief car inspector, Norolk & Western, Roanoke, Va. The first prize article follows, and the others, as well as abstracts from the best of the other papers which were presented in the competition, will be published in future issues.

CAR DEPARTMENT APPRENTICES

(FIRST PRIZE)

BY B. F. PATRAM
Southern Railway

The question of apprenticeship in either car building or car repairing today is one that requires a great deal more thought, study and consideration than it has ever received since its inception. With the proper training along mechanical lines very much better mechanics for the passenger department can be made out of bright, energetic boys than by any other method known to me. However, there are a great many things other than strictly mechanical ideas that should be instilled into the boy's mind during the first and second years of his apprenticeship. The main points that should be carefully considered are to train the boy to be watchful, alert, quick to respond and neat. The first impression made on the apprentice's mind is very important, for his mind is young and receptive and when the boy is made to see and understand he does not soon forget.

An apprentice in the passenger car department should have at least passed through the sixth grammar grade, or its equivalent in schooling, and his fitness or degree of education should be determined by an examination prepared by the head of the car department. After passing this examination, and it has been decided that the boy will start on his apprenticeship, he should be put to work, and should carry out the following schedule:

Six months building and repairing passenger car trucks;
Six months building and repairing platforms;
Six months in the mill, laying off work only;
Six months building and repairing engine cabs and pilots;
Twelve months working on the outside of passenger car bodies;
Twelve months working on the inside of passenger car bodies.

If this schedule is thoroughly carried out it should qualify the boy for any position in the car department. If, at the end of the first six months, the boy does not show the proper aptitude to make an efficient car builder and repairer he should be transferred to some other branch of the railroad business to which it is thought he is better suited. During the four years' course the importance of a technical education should be impressed upon the mind of the apprentice and everything possible should be done by those in authority to assist the apprentice in securing it. He should be offered every assistance possible in securing a thorough knowledge of the M. C. B. Rules, especially along the lines of interchange work and building and repair work.

As to the building and repairing of freight equipment cars, I am strongly of the opinion that an apprenticeship system in this department of the car business is not only unnecessary but offers no advantage either to the railroad or to the men employed in this branch of the service. However, I would advocate the use of helpers, who should be advanced as they qualify themselves to do this class of work. My reason for not advocating an apprenticeship course in the freight car department is as follows: First, there is no incentive for the young man to serve as an apprentice to a freight car builder or repairer because it would be necessary, owing to present conditions, for the boy to work side by side with men who were advanced from freight car helpers to freight car builders and repairers, in a much shorter time than is required in the apprenticeship course. Second, the pay of the freight car builders and repairers being so much out of proportion to the pay in other mechanical lines of railroad work, the railroad companies and the employing heads would have difficulty in securing the services of young men meeting the qualifications which would be required of them.

INDIVIDUAL PAPERS

The following papers were presented and will be published in future issues: Co-operation Between Yard and Repair Forces, by R. H. Dyer, Norfolk & Western; Passenger Car Work, by J. R. Schrader, New York Central; Car Department Organization and Efficiency, by C. R. Dobson, Chicago, Rock Island & Pacific; committee report on M. C. B. Billing and Repair Cards, J. V. Berg, New York Central, chairman; Interchange Inspection, by W. H. Sagstetter, Kansas City Southern, and J. J. Gainey, Cincinnati, New Orleans & Texas Pacific; Freight Car Maintenance, by J. J. Justus, New York Central, and H. H. Harvey, Chicago, Burlington & Quincy; Proper Loading of Cars, by W. H. Bettcher, Cincinnati, Indianapolis & Western; Handling of Equipment Repairs, by F. C. Schultz, Chicago; Sand Blasting Steel Equipment, by S. E. Breese; Passenger Car Work at Terminals, by C. Charlton. The following paper was also presented:

PASSENGER CAR CLEANING AND SANITATION

BY E. P. MARSH
Chicago & North Western

On the North Western the shopping period for passenger cars averages 15 months and it has not been found necessary to make a general practice of giving the cars intermediate light repair and cleaning. Cars regularly assigned to two and three day runs are thoroughly cleaned each time they arrive at a terminal, while cars on one day runs are given a thorough cleaning every other day. This cleaning consists of the following operations:

First—Open all sash.

Second—Blow out car from the top down, giving special attention to the curtain boxes, the space over the top sash, cushions and underneath the heating pipes and seats. Blowing out the cars has been found to clean them just as well as, if not better than, the vacuum system and it is much more rapid.

Third—Brush off the upholstery and dust off the wood work.

Fourth—Wash the entire car, including the inside of the sash and floor.

Fifth—Wipe all wood work with a renovator, care being taken to leave no greasy surface.

While this is going on in the interior the outside is washed by means of a hose and long handled brushes, and if it is very dirty it is given an oxalic acid wash. The trucks, gas tanks and other exposed iron work along the sides of the car are brushed off with a solution of kerosene and water which gives them a clean, bright appearance.

The interior cleaning has been found to be best handled by gangs of three—two men and a woman. The men do the heavier and overhead work and the woman, the saloons and lighter work. On the outside three-men gangs, two men with brushes and one with the hose—have been found to be the best combination. The cleaning and steaming with live steam of all water coolers is done by special men assigned to this work only.

The regular inspection for defects in the running gear and the adjusting of brakes is made by regular gangs as soon as cars arrive in the yard. This work is done on a day-work basis, as is also the work of the carpenter, trimmer, plumber and lamp repairing forces. All of the car cleaning work, except that of cleaning the water coolers, is done on a piece work basis.

Considerable difficulty has been found in properly disinfecting the cars. While formaldehyde will kill the germ life it has been found wanting when used for exterminating such vermin as roaches; after some experimenting we have found that the burning of sulphur in the presence of water will do this work in a satisfactory manner. In all passenger carrying cars, not equipped with carpets, an 18 in. aisle strip of linoleum set into the floor, has been found to be cleaner, more sanitary and more economical than carpet or cocoa matting aisle strips.

As is the case in most all work, when good work is desired, it must be well paid for. The piece work system has enabled

us to obtain this result with an indifferent class of labor; by practice and diligence the amount of work done by each gang has increased and by vigilant inspection it has been held up in quality, so that good work is now being done in sufficient quantity to make the work remunerative enough to hold the men and so avoid the trouble due to constant changing in forces. The keynote of any efficient cleaning yard is an organization which runs almost of its own accord and only needs the touch of the car foreman's hand in smoothing out the emergency kinks.

OTHER BUSINESS

Change in By-Laws.—The by-laws of the association were modified in two instances. Article 3 was changed to read as follows:

"The membership shall be composed of car department officials, car foremen, chief interchange inspectors, chief car inspectors, chief clerks, chief M. C. B. billing clerks, also representatives of any private car line in the same capacity as active members and car inspectors, air brake inspectors and representatives of any railway supply firm as associate members."

Article 4 was changed to read as follows:

"The officers of this association shall consist of president, first vice-president, second vice-president, secretary-treasurer and past president and seven elective members, who shall constitute the executive committee, the junior past president acting as chairman."

Secretary's Report.—The secretary-treasurer reported a membership of 554 and a cash balance of $379. There were 116 new members received during the convention. The secretary-treasurer was voted a bonus of $25 in recognition of his arduous labors during the past year.

New Officers.—The following officers were elected for the ensuing year: President, W. J. Stoll, chief interchange inspector, Toledo, Ohio; first vice-president, J. J. Gainey, general car inspector, C. N. O. & T. P.; second vice-president, E. Pendleton, chief interchange inspector, Peoria, Ill.; secretary-treasurer, W. R. McMunn, general car inspector, New York Central, Albany, N. Y.

Resolutions were also adopted on the deaths of S. Hornby, J. W. Hogsett, J. F. Skala, and A. Faerber.

ENTERTAINMENT AND EXHIBITS

The committee in charge of entertainment features was as follows: L. S. Wright, the National Malleable Castings Co. (chairman) Chicago, Ill.; J. R. Mitchell, W. H. Miner Co. (secretary-treasurer) Chicago, Ill.; Charles Derby, Joyce-Cridland Co.; J. L. Stark, Chicago-Cleveland Car Roofing Co.; A. M. Wilson, Galena-Signal Oil Co.; Marshall de Angelis, American Steel Foundries; C. J. Wymer, Grip Nut Co.; C. J. W. Clawson, Bettendorf Co.; and C. F. McCuen, Standard Heating & Ventilating Co.

The following supply companies had exhibits or representatives at the convention:

American Rolling Mill Company, Middletown, O. Represented by Warren E. McCann.
American Brake Shoe & Foundry Company, Mahwah, N. J.
American Steel Foundries, Chicago. Represented by F. L. McCune, M. DeAngelis and W. G. Wallace.
Ball Chemical Company, Pittsburgh, Pa. Represented by J. A. Gohen.
Bettendorf Company, Bettendorf, Ia. Represented by C. J. Clawson and J. Brady.
Boss Nut Company, Chicago. Represented by W. G. Willcoxson and W. J. Fogg.
Canfield Bros. Company. Represented by A. J. Canfield.
Curtin Supply Company, Chicago. Represented by G. E. Fox.
Chicago Railway Equipment Company, Chicago. Represented by E. A. LaBarr.
Chicago-Cleveland Car Roof. Company, Chicago. Represented by F. H. Williams.
Camel Company, Chicago. Represented by J. F. Comee.
Ft. Pitt Malleable Iron Company, Pittsburgh, Pa. Represented by A. M. Fulton.
Gold Car Heating & Lighting Company, New York. Represented by E. A. Robbins.
Galena Signal Oil Company, Franklin, Pa. Represented by A. M. Wilson, F. B. Smith, W. E. Auger, G. A. Arn, D. J. Justice, J. A. Graham and R. E. Webb.
Grip Nut Company, New York. Represented by C. J. Wymer, Albert Roberts and W. E. Fowler.
Heath & Milligan Manufacturing Company, Chicago. Represented by W. H. Pratt.
Hewett Rubber Company, Buffalo, N. Y. Represented by W. J. King.
Hale & Kilburn Company, Philadelphia, Pa.
Imperial Railway Appliances Company. Represented by V. E. Sisson.
Joyce-Cridland Company, Dayton, Ohio. Represented by Chas. D. Derby.
W. H. Miner, Chicago.
Magnus Company, Chicago. Represented by Bruce Owens.
Mahr Manufacturing Company, Minneapolis, Minn. Represented by H. H. Warner and J. R. Mathews.
McConway & Torley Company, Pittsburgh, Pa.
A. O. Norton, Boston, Mass.
New York Air Brake Company, New York.
National Malleable Castings Company, Cleveland, O. Represented by L. S. Wright, J. V. Davison and George V. Martin.
Pressed Steel Manufacturing Company, Philadelphia, Pa.
Q & C Company, New York. Represented by Albert Robertson and G. C. Pool.
Standard Railway Equipment Company, New Kensington, Pa. Represented by W. A. Brewer and J. T. Crawley.
Southern Wheel Company, St. Louis, Mo. Represented by Allen Dunham.
Standard Heat & Ventilation Company, New York. Represented by U. F. McCune.
Standard Car Truck Company, Chicago.
Scullin Steel Company, St. Louis, Mo.
Templeton, Kenly & Co., Chicago. Represented by A. H. Beattys.
Universal Draft Gear Attachment Company, Chicago.
Union Draft Gear Company, Chicago. Represented by J. E. Tarelton and C. J. Gorman.
Westinghouse Air Brake Company, Pittsburgh, Pa. Represented by A. L. Berghue.
Western Railway Equipment Company, St. Louis, Mo. Represented by R. L. Landtin.

THE ESSENTIAL REQUIREMENTS AND CORRECT TREATMENT OF HEADLININGS

BY H. M. BAXTER

The first, and most essential requirement of the ideal headlining material is absolute imperviousness to moisture, whether it be in the form of humidity in the atmosphere, rain, or as used for cleansing purposes. Needless to say, this is also the characteristic most difficult to obtain. Light weight is important; the material must not warp, and should not be affected by heat or cold, either moist or dry. Blistering or "spotting," splitting or separating are most serious faults, and no material with any tendency towards these defects should be considered as a headlining.

Metals will meet the majority of the above specifications, but there are two important draw-backs to the use of metal as headlining or other interior car finish. The first is its great heat conductivity, thus making the cars too susceptible to outside weather conditions and requiring too great an expenditure for heating. The second is that metal always looks, feels and sounds like metal. No paint or other finish can hide its identity.

There are numerous compositions on the market which take any finish very much the same as wood, are durable, practically non-conductors of heat and do not absorb moisture. In adopting a material of this nature, it is better, if other qualifications are even, to select one which is made in one solid homogeneous thickness, instead of being veneered or laminated, any form of lamination naturally supplying an opportunity for lodgement of moisture, which, being sealed up with paint or other finishing coats, is almost sure to cause blisters, splitting and warping.

Some of these compositions are not intended to be finished in any way and acids are used in their manufacture, which either repel or destroy paints, varnishes or marbleizing and polishing compounds. They are largely manufactured for use in electrical insulation work, and it was through their use as switch-board panels that it was found possible to use similar material for the interior trim of passenger cars. They are also largely used for bushings and numerous other items which require special molded shapes. In the manufacture, the material can be curved and shaped so as to fit any angle in the car structure.

For any considerable order, body panels, etc., may be molded to exact size, it remaining only to fit them into place and do the necessary finishing. All of these materials will saw like thin wood, or rather veneer, but owing to the non-grain texture, it is necessary to use a very fine tooth saw.

For filling in the cracks between boards, covering nail heads, etc., each of the manufacturers usually markets a composition calking compound, which possesses the same characteristics as its parent board. It can be filled, sized and finished, so that the entire surface presents the appearance of one board.

As the composition and finish of each factory is slightly different it is obviously impossible to lay down a fixed rule for procedure in finishing. All of the materials, however, are made from a pulp of vegetable fibre; and one at least, is solely poplar wood pulp, the others ranging from an all wood pulp through mixtures of wood, cotton, hemp, etc.

Being entirely a vegetable product, therefore, it is safe to say that the usual first coat of paint must be a filler. While the surface unevenness will probably not be so pronounced as in natural wood, this filing coat will nevertheless have to be well rubbed in, with a good, heavy bristle brush, preferably flat, and as large as the surface will conveniently permit.

The only exception to the use of a filler as a first coat is when the material comes from the factory with a thorough coating of waterproof. In such cases a "filler" would not only be useless but would not "take," leaving the surface blotchy and uneven, which condition would surely leave its mark through all successive coats. The foundation must always be smooth and good to produce an attractive finish. For waterproofed surfaces, a good size should be evenly and smoothly applied. An ideal first coat size may be made by mixing ¾ gal. commercial alcohol shellac and ¼ gal. alcohol. This is inexpensive, is readily secured and will go much farther than any varnish size.

After the first coat has been decided upon, correctly applied and allowed to dry thoroughly, the finishing coats may be commenced. As they will necessarily vary widely, it is hardly possible to discuss them in any comprehensive way.

FITTING UP CAR JOURNAL BRASSES*

Care should be taken in renewing journal bearings to see that they have a proper crown bearing, that the lining is not loose, and that the journal is not marred or scratched in any way. The journal wedge should not be too tight on the bearing, for it will pinch the edges of the bearing to the journal. The edges will then act as a wiper and prevent the proper lubrication of the center of the bearing. Neither should the wedge be too loose, for too much crown bearing will have a tendency to break the bearing, there being too much concentration of the weight on the crown.

The average workman engaged in taking care of the packing of boxes has had all of these points brought to his attention on numerous occasions, and should and does understand the causes of journal heating, and the methods he should employ to avoid it. Yet every railroad experiences periodical epidemics of hot boxes. The attention of everyone is brought to the matter when this occurs, and for some time box packing receives more than its share of supervision. As soon as this is relaxed, the men again become careless, and another epidemic results. These epidemics are costly and could be eliminated to a large extent, barring such unusual conditions as floods, etc., if, instead of waiting until hot boxes become so numerous that they have to be called to the attention of the higher officials, each car foreman should periodically check up his methods of packing boxes and assure himself that the matter is being handled in accordance with instructions.

*From a paper on Car Department Problems presented by E. E. Griest, master mechanic, Pennsylvania Lines, Ft. Wayne, Ind., at the General Foremen's Convention.

CLASP BRAKES FOR HEAVY PASSENGER EQUIPMENT CARS*

BY T. L. BURTON
Equipment Department, New York Central

The first requirements of a power brake are to stop the vehicle to which it is applied in the shortest possible distance, consistent with maximum rail adhesion, during emergency braking, and in the minimum distance, consistent with accuracy and smoothness, during service braking, all of which is largely dependent upon the type of equipment employed, the manner in which it may be operated and the braking ratio (percentage of brake power) that can be successfully used.

The braking requirements for present day heavy steel passenger car equipment can best be appreciated by a careful analysis of the records of a number of passenger train brake tests with the earlier light wooden cars and the heavy steel equipment of today, and for those who care to make such an analysis the paper which was presented by S. W. Dudley at the February, 1914, meeting of the American Society of Mechanical Engineers is unqualifiedly recommended. For ready reference, however, it might be interesting to state that in 1902 an exhaustive series of brake tests was made on the Pennsylvania Railroad, under the

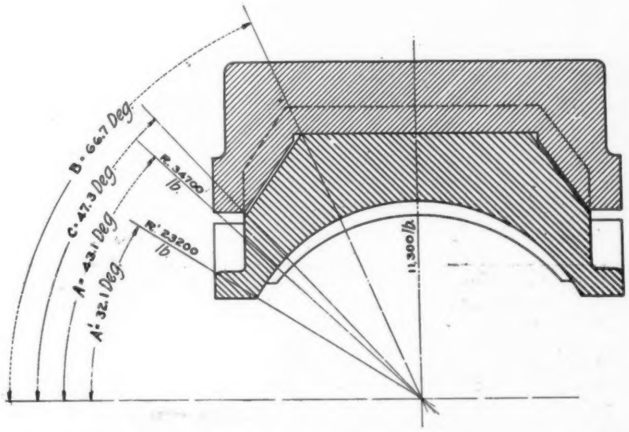


Fig. 1—Force Action on a 5-In. by 9-In. Journal; Car Weighs 150,000 lb.

supervision of A. W. Gibbs, with trains consisting of one locomotive and comparatively light wooden cars, in which stops were made from a speed of 60 m. p. h. with emergency brake applications in approximately 1,000 ft. In 1903 similar tests were made on the Central Railroad of New Jersey, under the writer's supervision, in which passenger trains consisting of what was then considered modern equipment, were stopped from a speed of 60 m. p. h. in an average distance of 970 ft. Early in 1905 another series of tests was made on the Pennsylvania Railroad with equipment similar in weight and construction to that used in the 1902 and 1903 tests with substantially the same results.

The emergency braking ratio in the Pennsylvania Railroad and the Central Railroad of New Jersey tests did not exceed 125 per cent of the car weight, and a reducing mechanism was employed for automatically reducing the braking ratio during the stops, so that the mean effective ratio was approximately 100 per cent. Based upon results obtained in the three brake tests just referred to, a distance of 1,000 ft. was considered a desirable theoretical emergency stop from a speed of 60 m. p. h. for a passenger train having the ordinary "high speed brake."

In the fall of 1905, closely following the second test of

*This paper is to be presented and discussed at the Railroad Section of the annual meeting of the American Society of Mechanical Engineers, New York, Friday morning, December 8, 1916.

the Pennsylvania Railroad, similar tests were made on the New York Central, under the supervision of C. H. Quereau. The locomotive and cars used in this test weighed, however, considerably more than the ones used in previous tests, and the emergency stops from 60 m. p. h. were over 1,200 ft., in cases where the air brake equipment and braking ratio were substantially the same as had formerly produced approximately 1,000-ft. stops with lighter equipment. Results of the New York Central test immediately established the fact that as the weights of the individual vehicles of which the train was composed increased, the braking ratio would have to be increased, if the length of the stop was to be no greater than was formerly made with lighter equipment, and to meet the requirements of the heavier locomotives and cars the air brake manufacturers immediately developed an air brake equipment with which could be had a higher braking ratio than was obtainable in previous tests with lighter locomotives and cars.

In 1908 another exhaustive series of tests was made on the Southern Pacific with still heavier locomotives and cars, in which it was found that a distance of over 1,300 ft. was required for stopping the heavier trains from a speed of 60 m. p. h. with no greater emergency braking ratio than was formerly required for making a 1,000 ft. stop with the lighter equipment.

In 1909, R. B. Kendig conducted still another brake test on the Lake Shore & Michigan Southern with trains consisting of locomotives and cars closely approximating present day equipment in weight, for which was required an emergency braking ratio of 180 to 200 per cent of the car weight for producing approximately a 1,200 ft. stop from a speed of 60 m. p. h. These tests demonstrated to the entire satisfaction of all who participated in them that the emergency braking ratio for heavy steel cars would have to be not less than 180 per cent of the car weight if the

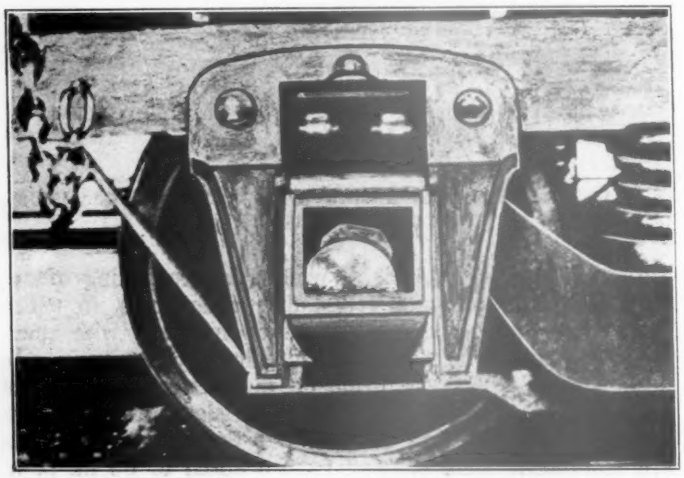


Fig. 2—Tilting and Displacement of Brasses and Journals with Single Shoe Brake; Four-Wheel Truck

emergency stops were to be made in no greater distance than formerly required for the lighter cars*.

Realizing that 180 to 200 per cent braking power applied to one side of a car wheel would probably produce ill effects on journals, brasses, trucks, etc., the writer had made a careful and thorough analysis of the force action on car journals as affected by high braking forces, and it is unfortunate that these analyses are of a character and magnitude which preclude the practicability of reproducing them in a paper of this kind, for they show conclusively the undesirability of applying to one side of the wheel a braking ratio of sufficient magnitude for stopping the modern heavy steel equipment in no greater distance than formerly required for stopping the lighter wooden equipment. A summary of these analyses are, however, shown in the accompanying illustrations.

Fig. 1 shows a section of an M. C. B. 5-in. by 9-in. journal, brass and wedge under a 150,000-in. lb. car with an average nominal journal load of 11,300 lb. Lines R and R^1 (Fig. 1) show the resultant of all loads acting on the journals with a single shoe brake, arranged in accordance with the M. C. B. recommendations for such a brake, and with an emergency braking ratio of 190 per cent. (R and R^1 are for different locations of wheels and direction of rotation.) It will be observed that the lines of action, R and R^1, are at a considerable distance below the supporting point between brass and wedge; that is, angle A is less than angle B and to push the journals out of the brasses during emergency braking is a natural thing to expect under the conditions stated.

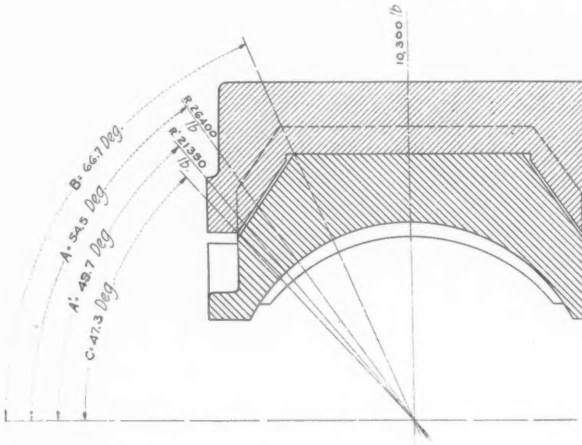


Fig. 3—Force Action on 5-In. by 9-In. Journal; Car Weighs 138,500 lb.

Fig. 2 shows the actual displacement of journals and brasses under service conditions closely approximating those described in Fig. 1. While this photograph is made from a four-wheel truck, the brake arrangement, nominal journal load, braking ratio, etc., are, as previously stated, substantially as shown in Fig. 1.

As resultant R is affected in direction and magnitude by the distance from horizontal center line of wheels to center of brake shoes at face, Fig. 3 was made to show a summary of the analysis of the force action on journals with brake shoes suspended 10 in. from rail (8 in. below wheel centers), which is lower than M. C. B. standard. The braking ratio employed in this case is approximately 160 per cent of the car weight. Angle A is still less than angle B and displacement of journals and brasses may be expected to result therefrom.

Fig. 4 is a photograph taken at the end of a stop with the car from which the summary analysis shown in Fig. 1 was made, and seems to confirm the analysis so far as concerns the effect of the braking load on journals. There seems to have been an open question in the minds of some as to whether the displacement of journals and brasses is controlled by the difference in angles A and B or A and C; that is, the points between which the brass is supported by the wedge seems to have been debatable, but a comparison of Figs. 1 and 2, and 3 and 4 should justify the statement that they are supported in their normal position only by the

*It is not the intention to show by the above references to brake tests the distance in which trains may be stopped in service. In conducting brake tests variations in equipment by which stopping distances are affected are necessarily reduced to a minimum, otherwise the results would not be comparative. The stopping distances referred to should, therefore, be used only as a basis of comparison for different equipments, and it should not be assumed that such stops would be reproduced in actual train service. On the contrary, it may safely be assumed that the stops with service trains should be much longer than test records show.

horizontal surface contact with the wedge, and if angle *A* is less than angle *B* the journals will be displaced.

To further check these conclusions an analysis was made of the force actions on a 5-in. by 9-in. journal of a 142,000-lb. car having six-wheel trucks, and a nominal journal load of 10,600 lb., with a service braking ratio of 85 per cent of the car weight and the arrangement of foundation brake gear the same as in Figs. 3 and 4. A summary of this analysis is shown in Fig. 5, from which it will be observed that Angle *A* is practically 5 deg. less than angle *B*, and in testing the cars out in road service, it was observed that some journals were displaced during service braking while others were not. The analysis as summarized in Fig. 5 and

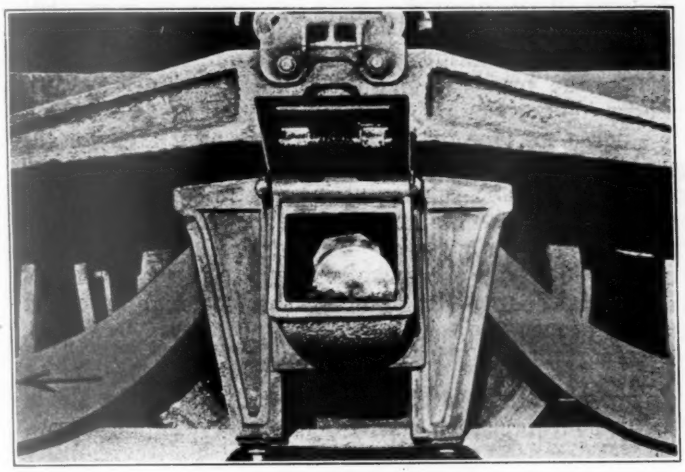


Fig. 4—Tilting of the Truck and Displacement of Brasses and Journals at Stop with a Single Shoe Brake; Six-Wheel Truck

the observations relating thereto strengthen the belief that if angle *A* is less than angle *B* the journals will be displaced. Also that where angles *A* and *B*, as determined from drawings, practically coincide there may be sufficient variations due to wear or construction of truck and brake details or rocking of brasses and wedges to change either of these angles sufficiently in service to cause the journals to be displaced or maintain a state of equilibrium.

It must be admitted that the high shoe loads applied to one side of the wheel only will produce undesirable results on journals and brasses as shown in Figs. 1 to 5 inclusive, and in addition thereto, it would seem from the discussion which is to follow that the conditions previously described are seriously objectionable from the viewpoint of train braking.

Consideration has been given to a change in brass and wedge design for the purpose of minimizing displacement of journals as referred to in the preceding discussion, but if this is done, it will still be quite difficult to stop the heavy steel car in substantially the same distance formerly required for the lighter wooden car. While on the other hand, it has been conclusively demonstrated that with a properly designed and constructed clasp brake the maximum available rail adhesion can be utilized in train braking, thereby reducing the emergency stops to a question of adhesion rather than permissible braking ratio. It is, therefore, the writer's opinion that a suitable design and make of clasp brake should be used on modern steel passenger equipment, the advantages of which are, briefly stated, as follows:

SAFETY

In case of danger, requiring an emergency brake application, a much shorter stop can be made with the clasp brake than with a single shoe brake, other conditions except those affected by the brake gear being the same in both cases.

If properly designed, manufactured and installed, there is no occasion to disconnect any part of the clasp brake rigging between shopping of cars. The probability of the brake becoming inoperative through a failure to properly replace cotters when disconnecting the brake with the car in transit and the loss of brake pins resulting therefrom is reduced to a minimum.

A thin brake shoe, or the loss of a brake shoe, does not always necessitate cutting out a brake to save the brake beam.

If the clasp brake is properly designed, manufactured and applied to the car it will be practically impossible to adjust the rigging so as to impair its efficiency or interfere in any way with its proper operation.

The axles and truck frames, in addition to performing their usual functions, become safety hangers for the major portion of the brake rigging, thus reducing to a minimum the possibility of derailment that might be caused by brake rigging dropping on the track in case of failure of the truck brake gear.

While the possibility of disconnected brake parts dropping on the track is greatly reduced in comparison with the single shoe type of brake gear, the danger is further reduced on account of the clasp brake parts being much lighter than those of the single shoe type.

ROUGH VS. SMOOTH TRAIN HANDLING, ACCURACY IN MAKING STOPS, ETC.

Many modern passenger trains are, on account of the inherent shortcomings of the "single shoe" type of brake, extremely difficult to handle smoothly. Careful investigation of the complaints of roughly handled passenger trains indicate that most of these troubles are due largely to non-uniform braking power and the *time in which it is developed*, as a result of improper piston travel.

In service braking at low speeds, whether for the purpose of stopping from such speeds or for completing stops from high speed, such as making a *second brake application* as the stopping point is approached, the brake power should be light and the retardation resulting therefrom must be developed slowly, or simultaneously on all cars, if smooth

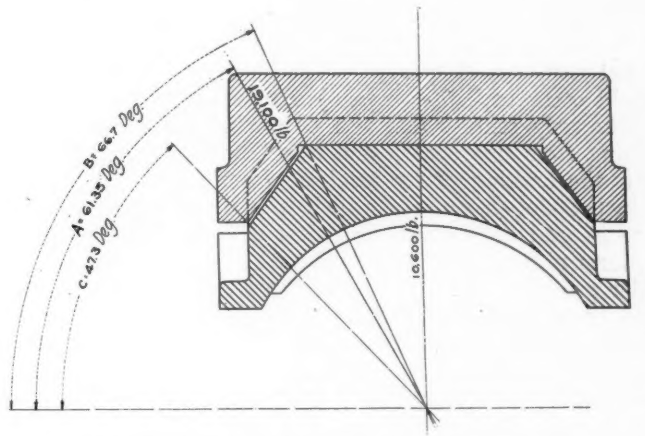


Fig. 5—Force Action on 5-In by 9-In. Journal with Service Brake Application; Car Weighs 142,000 lb.

handling is to be insured. Smooth service stops from all speeds are also contingent upon the flexibility of the brakes.

The seriousness of slack action shocks are greater than in former years on account of the greater average weight of cars and increased length of trains, and the chances for producing them are much greater with the single shoe brake than was the case with lighter cars and shorter trains.

Contrasting the desired rate at which the braking power should be developed at low speed, making service or emergency stops from high speed in a minimum distance necessitates developing a high nominal braking power, and in addition thereto it must be developed rapidly. The rate at which both service and emergency braking power is devel-

oped is largely dependent upon piston travel, and with a view to producing the best results under all conditions the automatic brake is built on the principle of maintaining, as near as practicable, 8 in. piston travel at all times and under all conditions. As an example, if, during service braking at low train speeds, the piston travel resulting from 10 lb. brake pipe reduction is only 5 in. instead of 8 in. (with some brake riggings it is 5 in. or less) the braking power will be fully 100 per cent greater than with the predetermined standard piston travel of 8 in., and with the shorter travel a 10 or 15 lb. reduction will practically equalize the auxiliary reservoir and brake cylinder pressure, thereby materially reducing the flexibility of the brake. While the vibration of the car may cause the 5 in. piston travel to increase to practically normal before the stop is completed, it will not do so except when stopping from high speed. Moreover, if the travel does increase before the stop is completed it will contribute nothing to smooth handling, as the shock will have occurred while the travel was short.

Other things being equal, the clasp brake will develop a higher percentage of braking power than the single shoe brake during heavy service or emergency applications, but for light service braking at low speed the brake power developed from a given brake pipe reduction is much less with the clasp brake than with the single shoe brake, and it is developed at a much lower rate, thereby insuring smoother train handling than can be had with the single shoe brake.

The results just cited are due to the fact that with the single shoe brake the piston travel is practically proportional to the cylinder pressure developed, whereas with the clasp brake, with a shoe on each side of the wheel, the horizontal wheel or shoe movement relatively to the brake cylinder is reduced to a minimum, and such movement if produced from any cause will have no effect on the piston travel. Moreover, with the clasp brake the shoes are located sufficiently close to the horizontal center line of wheel centers to obviate the *pulling down* of truck frames and variations in piston travel resulting therefrom.

The removal of worn shoes and their replacement by a given number of new shoes without readjustment of slack, as is frequently done on long runs, will not affect the piston travel with the clasp type of brake to the same extent as would occur with the single shoe type of brake.

The only remedy that can be offered for the difficulties arising from improper piston travel, which so seriously affects the braking power resulting from a given brake pipe reduction and the rate at which it is developed, is to apply a truck and body brake gear that will substantially insure uniform piston travel under all conditions of speed and cylinder pressure. The use of the clasp type of brake rigging with body brake gear to suit will, to a large extent, accomplish these results and restore the flexibility of brake operation which existed prior to the adoption of extremely heavy cars and long trains equipped with single shoe brakes.

IMPROVES RIDING QUALITIES OF EQUIPMENT

The high brake shoe loads developed on one side of the wheels with a single shoe brake produce a binding effect between pedestals and oil boxes, which interferes with the proper action of the truck springs during an application of the brakes, and when the shoes are hung low, as is necessary with the ordinary six-wheel truck and single shoe brake, the pulling down effect of the truck defeats in many cases the purpose of the truck equalizing springs. This binding between pedestals and oil boxes and the increased load on truck springs causes the car to ride hard when brakes are applied. This does not occur with the clasp brake.

ELIMINATION OF HOT BOXES

With the single shoe type of brake rigging it will be observed that the high pressure exerted by the shoe on one side of the wheel causes the tilting of brasses sufficiently to lift one side of the brass a considerable distance away from the journal (see Figs. 3 and 4) so that a wide space is open for waste to be caught between the brass and the journal when the brake is released and the brasses and journals resume their normal position. Investigation has shown that waste has been found wrapped around the journal, and that the collars on the axles are forced against the sides of the boxes. Further, these effects are not confined to emergency applications, but will also be noted in service applications of the brake and are all in the direction of producing hot boxes, while the unequal distribution of braking power and binding between boxes and pedestals has a tendency to cause slid flat wheels.

DECREASE IN MAINTENANCE COST AND BRAKING SHOE COST

While the principal advantages inherent in the clasp brake, of greater flexibility in service braking, etc., are outlined in the foregoing and the primary consideration for its adoption must be the increased emergency efficiency over the single shoe type of brake, providing as it does for the possibility of greatly shortened stops, with a lesser tendency to slide wheels, and consequent increase in safety, the clasp brake will also, due to the principles involved in its design and construction, show a decided decrease in cost of maintenance, not only in the brake rigging itself, but a substantial decrease in the cost of brake shoe material for equal amounts of energy dissipated.

COST OF TRAIN OPERATION

Investigation has developed the fact that with the single shoe type of brake on modern passenger equipment cars and the piston travel adjusted to proper limits, approximately 35 per cent of the available tractive effort of the locomotive was consumed in pulling the train against the effect of brake shoes dragging on the wheels with the brakes released. (See M. C. B. Assn. Proceedings, 1910, page 97, paragraph 3). With the clasp type of brake and the resulting increased shoe clearance, this loss is eliminated, leaving better maintenance of schedules and corresponding decreased cost of train operation.

CONCLUSIONS

In considering the application of clasp vs. single shoe brakes to the modern heavy steel passenger car of today the advantages of the former over the latter, as enumerated above, are but secondary to the primary question to be settled, namely: Are the present day trains to be stopped from given speeds in no greater distance than was required 10 to 15 years ago for stopping the lighter wooden cars? If so, the question of whether or not an efficient clasp brake should be used on such trains is conclusively settled. The collision energy of the heavy steel passenger train as compared to the lighter wooden train has increased directly in proportion to the increased weight, and in geometrical proportion to the increased speed, in cases where speeds have been increased, to say nothing of the increased density of traffic. It would, therefore, seem that the use of a clasp brake is essential in successfully controlling the speed of present day or future passenger trains, and without regard to nominal increase in first cost or multiplicity of parts of brake gear resulting therefrom.

The foregoing discussion on the relative performance of the clasp and single shoe brake is with the distinct understanding that the former is designed upon a scientific engineering basis and is constructed and installed in accordance with the principles involved in the design, for while the claims made for the clasp type of brake have been conclusively demonstrated by exhaustive tests and road service, it has likewise been demonstrated that where the clasp brake is improperly designed or carelessly manufactured and installed the results obtained in service are in many respects less desirable than with the single shoe brake.

REFRIGERATING FREIGHT IN TRANSIT*

A Discussion of the Results Obtained in Tests Made on Different Types of Refrigerator Cars

BY M. E. PENNINGTON

Food Research Laboratory, Bureau of Chemistry, United States Department of Agriculture

THE people of the United States are as dependent upon refrigerator cars for their food supply as are the people of England upon her ships. The English refrigerated food ship is the result of a systematic evolution; the American refrigerator car, like Topsy, has "just growed." The United States has now well over 100,000 refrigerator cars belonging to railroads. It costs at least $1,500 to build a refrigerator car, and most of them are in need of rebuilding after five years of service. With such an investment and cost of maintenance, and with the responsibility of transporting fresh food to the people, we may well inquire into the efficiency of the car, and into the expense involved.

The United States Department of Agriculture, through the Bureaus of Plant Industry and Chemistry, has, for some

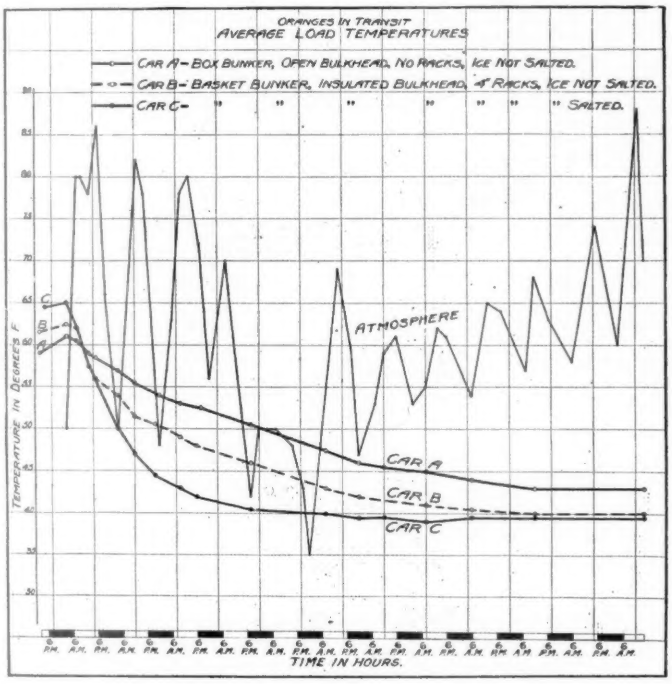


Fig. 1

years, been studying the temperatures required to preserve perishable produce in transit. The department has obtained definite information on fruits, vegetables, dressed poultry and eggs. It is now determining the most efficient and economical means of transporting these perishables. The problem is of great importance to the shippers, to the railroads, and to the consumer as well.

The efficiency of the refrigerator car depends upon such factors as the quantity and kind of insulation, the type and the capacity of the ice bunkers, the size of the car, the temperature of the entering load, the manner of stowing the packages, the circulation of the cold air from the ice bunkers, and the freedom of the insulating material from moisture. The economy of operation depends on such factors as the weight of the car in relation to the weight of the load, the amount of ice required to cool the product in transit, or to maintain the initial temperatures of the precooled load, and the length of life of the car. All these, and other questions are the subject of investigation in the Department of Agriculture in connection with the study of the preservation of the good condition of perishables while in transit. Apparatus and methods of investigation had to be developed to obtain the necessary data. Gradually there has been evolved an arrangement of electrical thermometers which can be installed not only in appropriate locations in the car but within the packages, and even inside an orange, peach, chicken or fish. The wires

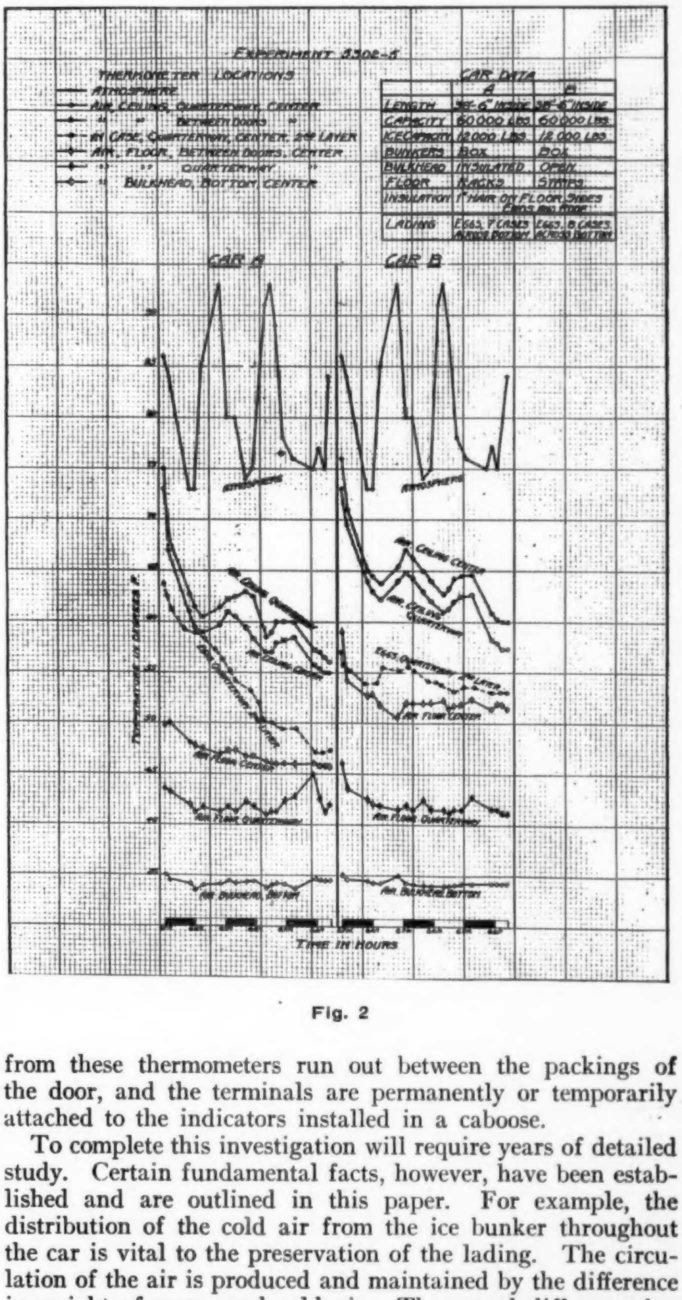


Fig. 2

from these thermometers run out between the packings of the door, and the terminals are permanently or temporarily attached to the indicators installed in a caboose.

To complete this investigation will require years of detailed study. Certain fundamental facts, however, have been established and are outlined in this paper. For example, the distribution of the cold air from the ice bunker throughout the car is vital to the preservation of the lading. The circulation of the air is produced and maintained by the difference in weight of warm and cold air. The actual difference between the weight of a cubic foot of air at 65 deg. F. (1.18 oz.) and 32 deg. F. (1.27 oz.) is only 0.09 ounces. Experi-

*This paper was presented before the Traffic Club of Chicago, October 6, 1916.

ments with stationary precooling plants, cooled by ice or by ice and salt, have shown that the best and most economical results are obtained by hanging a basket of suitable ice capacity close to, but not actually free from the walls of the room, and closing off the basket by an insulated bulkhead open about 12 in., both at the top and bottom, to permit entrance and exit of air. In this way a large surface of ice is exposed to air contact and the air is compelled to travel over the entire column of ice before it escapes. The insulated bulkhead prevents the absorption of heat from the commodity and from the car, varying in quantity according to the distance from the ice. The bulkhead also facilitates a steady ascent and progression of the warm air in the car toward the top of the bunker. To further facilitate the distribution of the cold air, floor racks 4 in. high have been installed.

Now let us see what practical results such a combination produces when applied to a refrigerator car which is, in other respects, of the usual type. Fig. 1† shows the average temperatures in three cars of oranges in the same train in transit between Los Angeles and New York, each car containing

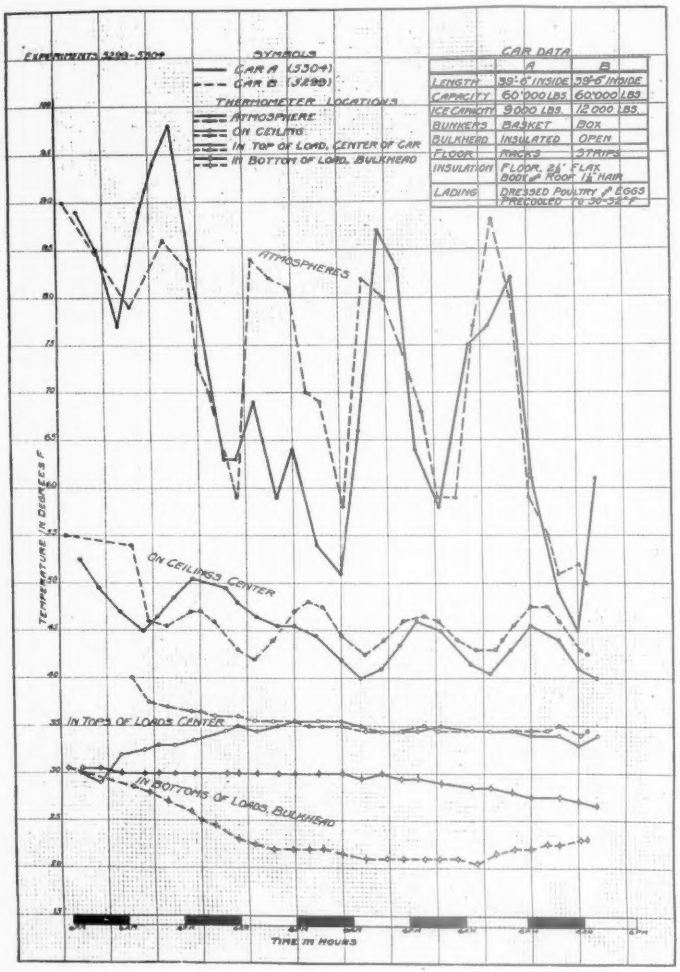


Fig. 3

462 boxes of fruit. Car *A* had the box bunker and open, or slatted, bulkhead so commonly seen in present day refrigerators. The lading was placed directly on the floor. Car *B* had a basket bunker, insulated solid bulkhead, and a rack 4 in. off the floor. Car *C* was of the same construction as car *B*, but the ice was mixed with 9 per cent salt the first day and 5 per cent of the added ice on the second. The temperature of the load in car *A* averaged 54.4 deg. F. The temperature of the load in car *B* averaged 49.5 deg. F., while car *C*, in which salt had been added to the ice, not only cooled the oranges more quickly but reduced the average temperature of the load to 45.4 deg. F., a gain of 9 deg. F. as compared with car *A*. The amount of ice placed in the bunkers in car *A*, including that remaining in them at destination, was approximately 23,200 lb. In car *B* the ice amounted to 18,675 lb., a saving of more than two tons. Car *C*, which had been salted, had 22,750 lb., still a little less than car *A*.

The results obtained with car *C* open up great possibilities

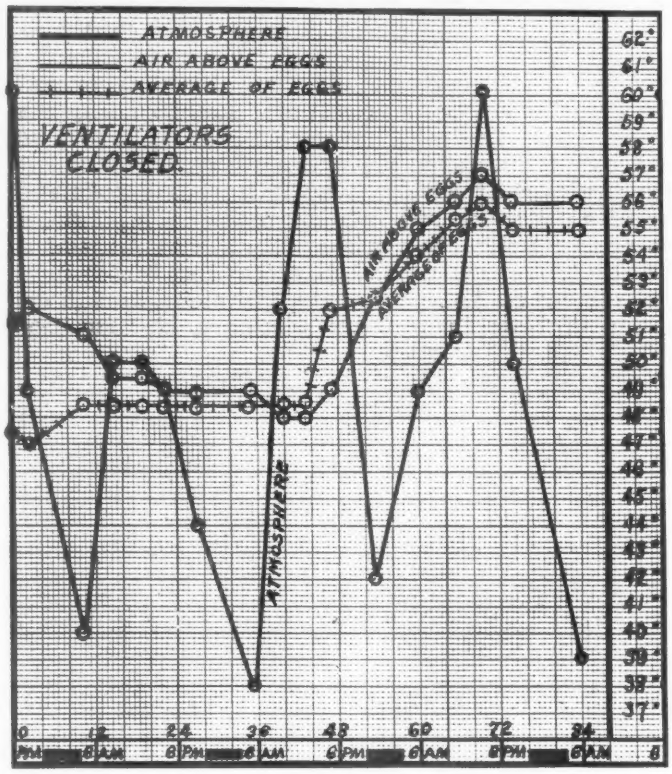


Fig. 4

in the better distribution of such extremely perishable products as strawberries, raspberries and cherries, widely produced under conditions which generally preclude proper precooling before loading into the car. The insulated bulkhead prevented the frosting of the lading next to the bunker, and the floor rack provided a quick runway for the very cold air, which soon lost its temperature of 20 deg. F., or even less, by the absorption of the heat of the lading and the car.

Such results with the basket bunker, insulated bulkhead and floor rack, combined, naturally raise the question of the relative value of each of the three factors in producing and maintaining circulation, and gaining the available refrigeration from the ice. Experimentation shows that a rack on the floor of the car hastens the cooling of the load, and affords very decided protection to the lower layer of goods against both frost and heat. The floor rack alone, however, is far less efficient than the combination of the basket bunker and insulated bulkhead with floor rack. The addition of insulation to the bulkhead increases circulation and the lading is more rapidly and completely cooled than when the bulkhead is either not insulated or is open. For example, Fig. 2 shows two cars of similar size and construction, one of which was provided with a floor rack and an insulated bulkhead, the other as commonly used. Both were loaded with eggs. The car with the insulated bulkhead and the floor rack reduced the average temperature of the load 17 deg. F. in 64 hours. The load in the ordinary car showed a reduction of 7.5 deg. F. during the same period. The average temperature of the car with the insulated bulkhead and the floor racks

†The study of fruits and vegetables is being conducted by the Bureau of Plant Industry under the supervision of H. J. Ramsey. I am indebted to him for the data on oranges and also such other facts concerning the transportation of fruits and vegetables as are brought out in this paper.

was 5.5 deg. F. lower than the ordinary car. That it is not advisable to cease improvements with the floor rack and the insulated bulkhead is indicated by experiments which show that the quick cooling by ice and salt safely performed with the basket insulated bulkhead and floor rack is not possible without it. The pocketed cold air at the box bunker, which is always observed with bunkers of the box type, causes frosting of the goods against the bulkhead even when insulated.

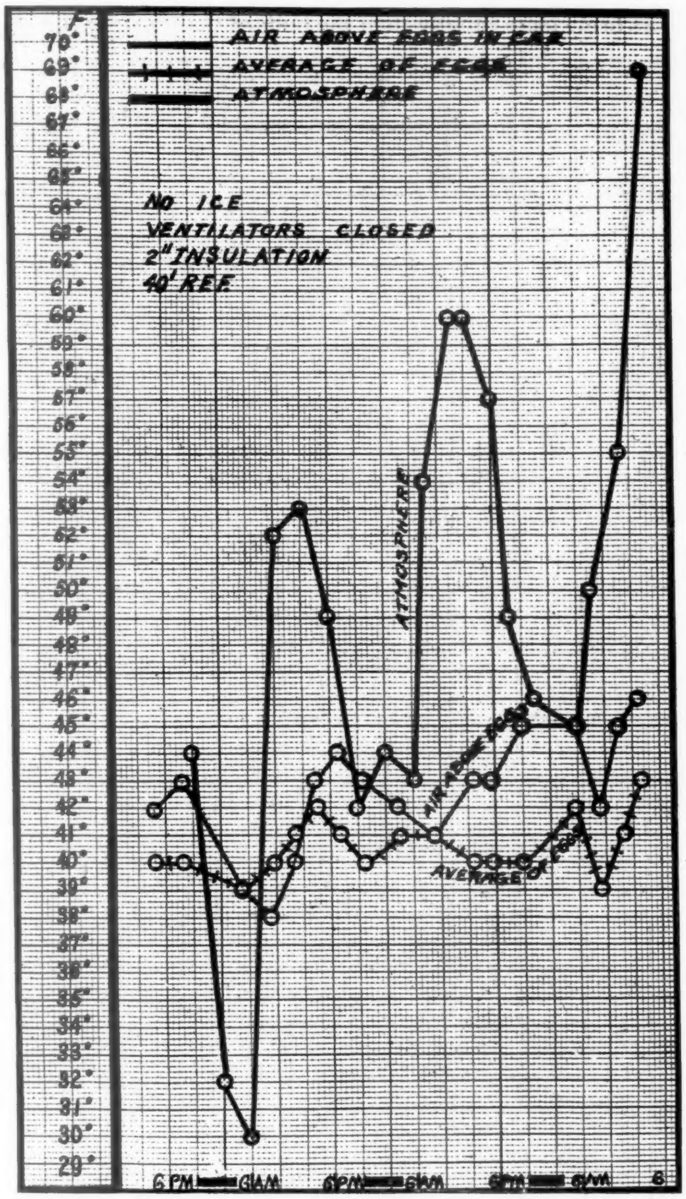


Fig. 5

The failure of refrigerator cars to maintain even temperatures throughout the load has been a serious menace to extremely perishable products. In order to produce temperatures at the top of the load between the doors—commonly the warmest place in the car—low enough to carry dressed poultry safely, it has been necessary to freeze the birds at the bunker. While freezing in transit does not injure the food value of dressed poultry, it does lower its money value at certain seasons or in some markets. Better air circulation tends to equalize temperatures, as shown in Fig. 3. In the car with the box bunkers and open bulkhead (car *B*), where the load was placed on floor strips, the package at the bunker on the floor froze solidly (23 deg. F.) during a four-day haul, although the package on the top of the 4 ft. load was 35.4 deg. F. A similar car (car *A*), except that it had a basket bunker with an insulated bulkhead and a floor rack, maintained an average temperature of 29.3 deg. F. at the bunker and 34.1 deg. F. in the package on the top of the load between the doors. In the one case the average difference between the warmest and coldest points in the car was 12.3 deg. F.; in the other 4.8 deg. F.

The reduction of the temperature on top layers can be increased by better and more judiciously applied insulation, especially in the roof of the car. Most of the cars in service have the same amount of insulation throughout, regardless of the additional straw on the roof during the heat of summer, and on the floor when frost protection is necessary. Experiments are now under way to determine just how much insulation it is advisable to have in roof and floors as well as in the body of the car. At present the work indicates that there is scarcely a car in the country which is sufficiently well insulated to be an economical as well as safe carrier of perishables.

A large proportion of the refrigerator cars now in service have one inch of insulating material over the entire car. Some have two inches throughout, and a few, comparatively, have had especial care bestowed on the insulation of the roof and the floor. The lack of sufficient insulation, especially on the roof of the car, has been responsible for the fact that the top layers of such fruits as peaches, strawberries and cherries are so different in quality from the rest of the carload that they must be sold as separate lots. The higher temperature of the upper half of the car has led the shippers to urge longer cars, that they might extend rather than heighten the stacks of packages. As a result of this, and also in line with a general increasing of the capacity of all cars, the refrigerator has been lengthened, regardless of the fact that heat transmission increases directly as the number of square feet of surface enclosing the car space. For example, a car whose roof, floor, walls and ends aggregate 1,170 sq. ft., and which is 33 ft. between linings, has the same amount of temperature protection with 2 in. of insulation as a car with 2.5 in. of insulation whose surfaces aggregate 1,407.5 sq. ft., and whose length between linings is 40 ft. 6 in. To determine the economical size of a refrigerator car in relation to the height of the lading, the consumption of ice, the total weight of the car and its initial cost, is an economic problem of importance. Studies to obtain such information are now in progress.

The most obvious results due to increased insulation are, first, better protection to the lading against both heat and cold, and, second, a saving in the use of ice. The modern trend in the handling of perishables is to include a precooling as a preparation for shipment, and it is a highly desirable practice from all viewpoints. When the goods enter the car at a temperature conducive to preservation, it is the business of the car to maintain that temperature. The goods need no further refrigeration, and the ice in the bunkers is required only to overcome the heat leakage through the walls. The difference in performance of a car with one inch of insulation, as compared with a similar car, except that the latter was provided with 2 in., is shown in Figs. 4 and 5. Both cars were loaded with eggs and closed without putting any ice in the bunkers. The weather at the loading point was cool enough to ensure a cool car. The possible dangers—against which the insulation was to protect—lay ahead. Fig. 4, showing the performance of the car with one inch of insulation indicates very plainly that it could not protect the eggs. Fig. 5, on the other hand, shows that 2 in. of insulation, even with higher atmospheric temperatures, delivered the eggs at destination at practically the same temperature as they entered the car, and the maximum variation was but 4 deg. The one inch car needed 10,000 lb. of ice—the 2 in. car needed none. Is it any wonder that wide-awake shippers are picking out their refrigerator cars more and more carefully?

Experimentation indicates that marked economies can be effected in the consumption of ice in transit aside from the question of insulation. Raising the load off the floor, inducing a circulation of air in the car, and bringing a large

surface of ice into contact with the air, tends to reduce the amount of ice used. As stated in another connection in this paper, a carload of oranges in a car having box bunkers with open bulkheads, and without a rack on the floor, had 23,200 lb. of ice put into the bunkers between Los Angeles and New York. A similar car provided with basket bunkers, insulated bulkheads, and a floor rack had 18,675 lb. Neither load was precooled.

That precooling of the lading means fewer icings in transit is a matter of common knowledge. That by hard freezing of the goods, they not only do not require additional chilling in transit, but actually furnish refrigeration to the car, is not so commonly recognized. Fig. 6 shows the temperatures in transit of 20,000 lb. of poultry, which went into the car at zero F. The railroad icing record shows that 4,700 lb. of ice was added during the eight-day haul and 470 lb. of salt. Other experiments, under comparable conditions, show that nearly 5,000 lb. of ice is used by cars carrying 20,000 lb. of poultry chilled to 30 to 32 deg. F. during a four-day haul, or approximately twice as much.

The temperature records show that the poultry grew gradually warmer, faster on the top and bottom of the load, where the heat leakage from roof and floor was most pronounced, and most slowly in the center of the load, where the packages protected one another. The chart also shows that the amount of salt added during transit is insufficient to maintain the temperatures produced on the initial salting, when the full 10 per cent of the weight of the ice was present. It must be remembered that the salt bores through the ice and escapes as brine more rapidly than the bulk of the ice melts, hence it is in constantly decreasing proportion. Icing and salting rules take no account of this fact. It is quite obvious that different rules must be formulated if efficiency is to be secured. This problem, like all the other problems confronting the shipper and the carrier who are engaged in getting perishables to market in good condition, can be solved only on the basis of exact knowledge. That knowledge the United States Department of Agriculture, in co-operation with the shippers and the railroads, is now endeavoring to acquire and to pass on to all whom it may benefit.

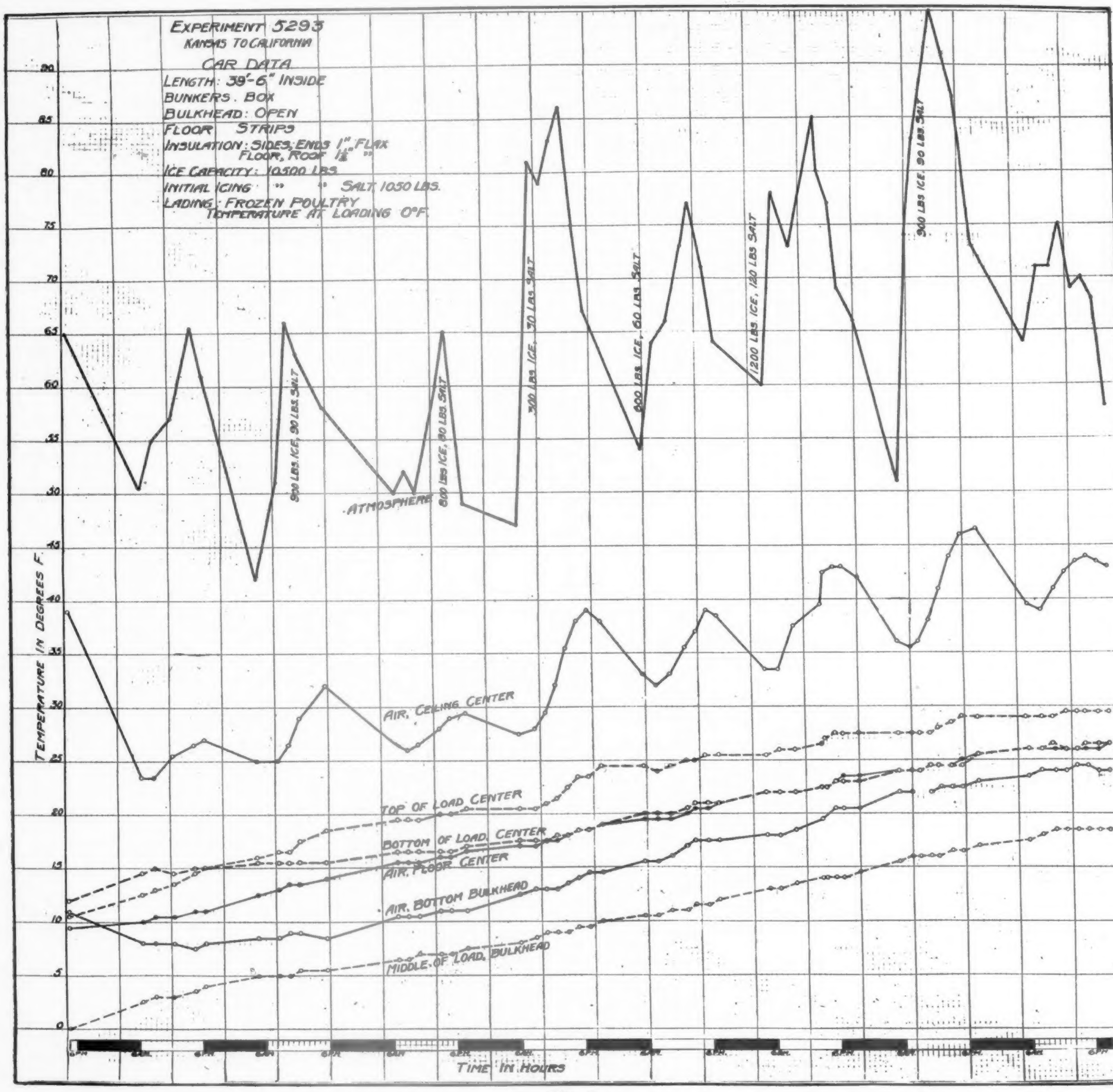


Fig. 6

Shop Practice

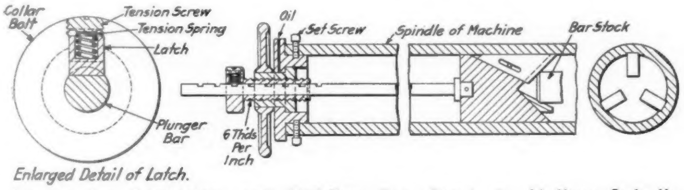
PLUNGER FOR HOLDING BAR STOCK

BY EDW. F. GLASS

The drawing shows a plunger for holding round or hexagon bar stock in the center of hollow spindle machines. This device is especially designed for machines having the larger diameter bore in the spindles.

In practice we have had considerable trouble in holding the material true and steady with the chuck jaws only, as the portion of the bar that extends back through the spindle would flop around, causing the material to work loose in the chucks and break the tools. This is hard on the chucks and it is impossible to get a finished or true piece of work out of the machine.

The device as shown consists of a plunger and rod. The body of the plunger is about 1/16 in. smaller than the diameter of the spindle, and is fitted with three segments, which come in contact with the stock in the machine, and when the body of the plunger is forced against them they are expanded against the inside walls of the spindle, thus holding the material perfectly true and solid. The adjustment device consists of a collar bushing that fits the end of the spindle, with a collar nut having a working fit on the inside of this bushing. On the end of this nut there is keyed a hand wheel. A screw bolt bored the diameter of the plunger rod is fitted in the collar nut and the larger diameter is fitted with a key latch that is held in place by a spring and cap screw to give it the required tension. In order to readjust this device it is necessary to loosen the hand wheel, turn the collar a quarter turn, push the plunger rod in until it engages the bar stock, turn back the collar and turn the hand wheel until the latch engages the next slot in the plunger bar; after the latch falls in, screw up by the hand wheel to the proper tension.

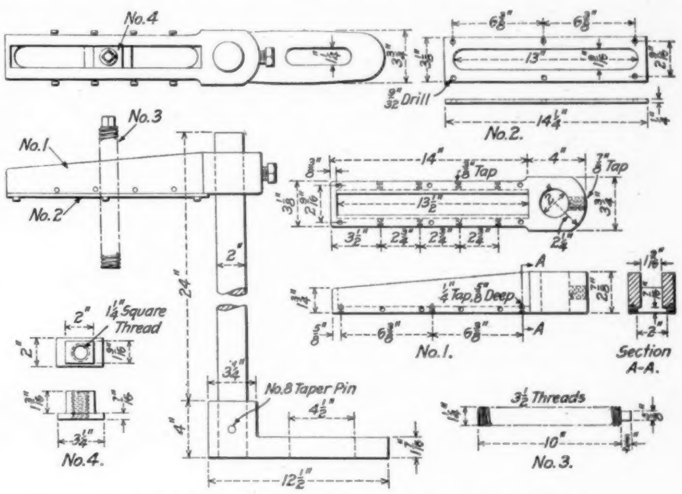


Device for Centering and Holding Bar Stock in Hollow Spindle Lathes

OLD MAN DRILLING POST

BY LEROY SMITH

The accompanying engraving shows the general arrangement and details of an old man drilling post. This drilling post is made of soft steel, the drawing of which shows the details, and is self explanatory. One of the principal features of the post is the adjustable center, *No. 3*. By loosening or tightening the screws at the bottom of *No. 1*, this center is easily shifted laterally. This at once obviates the necessity of putting the drill in place, and center punching on the bottom of the ordinary arm so that the point or screw of the drill will not run. Another feature is the ability to adjust vertically the center of the drill. Aside from this it also has the advantage that when the feed screw of the drill has been run out, the center, *No. 3*, may be screwed down and the arm, *No. 1*, does not need to be shifted in order to drill deeper. It would appear at the first glance that this arrangement might possibly not be very stable, but the experience so far has been entirely satisfactory.



Details of Drilling Post with Adjustable Center

This device was designed by J. A. Hamburg, machinist in the Pennsylvania shops at Olean, N. Y.

INCREASING SHOP OUTPUT

BY H. D. WOLCOMB

Throughout the country there are many railroad repair shops which overhaul from 8 to 12 general repaired engines a month. Each shop has a system for handling the work that differs in some respect from all others, yet, invariably each shop claims its system to be the best. Local conditions may necessitate, to a small extent, certain slight deviations from a uniform plan of handling general repairs. But a shop which cherishes the delusion that it is superior in all things to all others, will be found just as inefficient as the shop which admits it is out of date.

In the sense of detailed, impartial, systematic and comprehensive interchange of experience, railroad repair shops are practically isolated units. One great trouble is that the average shop foreman does not read enough in the line of his work, and invariably when he visits other shops he returns home most impressed by those practices in which his own shop surpasses, losing sight of the valuable suggestions as to where he can improve his own conditions. In the following discussion of increasing shop output, it is intended to recommend only such economies as are definite in terms and certain in results, offer suggestions that can be put into immediate operation with present shop equipments, and that will not conflict with industrial conditions or require a large expenditure of money for improved machinery. Many shops have the system of special gangs for dismantling the engine before it is placed in the erecting shop for overhauling and rebuilding. This method is economical for the large shop

but during the present age of saving everything of any possible value, and the scarcity of common labor, it is not the most efficient method for the small or medium size shop. Industrial plants claim that much money is wasted by watching the high salaried officer and not paying enough attention to the common laborer, which is just as true in the railroad shop for the common laborer can do much damage and waste much material if left to his own resources. If the same foreman is responsible for the replacement of material which he removes, it is a fact he will see that more care is taken in removing and storing it for future use. Misplaced material or material ruined in removal amounts to a large sum and in turn retards the quick overhauling of an engine. Also by having the same foreman responsible for the removal of material, he is better able to keep an accurate record of the cost of repairs to his engine. In order to promote a feeling of pride, as well as to give proper credit to the foreman exercising the best judgment, a complete detailed cost of repairs to each engine should be posted. By doing this, it will be found that some foremen have been turning out quick repairs at the sacrifice of costly material.

Another big item of expense in the medium sized shop is the delivering of material about the plant when engines are dismantled at some one point. By dismantling and rebuilding on the same pit, the cost of delivering material will be saved and the men can use their time to good advantage in making repairs. While specialized repair work may be economical for large shops where there is enough work to keep the specialist busy, in the small shop there is too much time lost in changing from one job to another, or in waiting between jobs on account of the work coming to him at irregular intervals.

Encourage the shop foremen by paying good salaries and in addition, giving a certain per cent of whatever can be saved in material by good management, and also for completing the work under the specified time. If industrial organizations have found that giving commissions in addition to salaries to their salesmen for obtaining extra business is good policy, why will not the same idea work out in the railroad repair shop? Giving a small bonus to the shop foremen brings out the good men, increases the output at no increase in cost, saves valuable material, and promotes better feeling between the company and its employees. Often when some foreman is given an increase in salary, his brother workers will look on it as a sort of favoritism, but if the bonus is given for actual services rendered in getting out work, the best man is bound to receive the benefit, and there can be no grounds for dissatisfaction.

The assignment to him of too many duties is one of the drawbacks to the foreman's output. It is possible to overload the foreman with so many men that his entire gang is run on an inefficient plan. He jumps—mentally and physically—from one idea to another all day long. Increasing the number of workmen in a gang does not always mean an increased output in proportion to the number of men added. One gang of 32 men was overhauling nine engines a month and the gang was increased to over 70 workmen with the addition of an assistant foreman, yet the output was only increased to 12 engines. In this case, the number of workmen was increased over 100 per cent with a corresponding increase in output of only 33⅓ per cent. Industrial plants will prove by actual figures that it is folly to overload any foreman with too many men. Today when the foreman should follow the ordering of material, instruct inexperienced workmen and check to some extent his daily costs of operation, a gang of 25 men is the limit for efficient and economical handling.

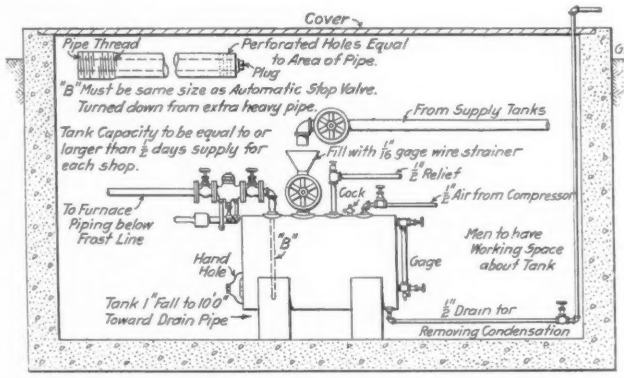
Too much time should not be wasted on keeping a record of small details yet there are some records that are important. Many men have failed simply because they paid too much attention to insignificant details while, on the other hand, men have failed because they paid no attention to details that should have been watched. Some foremen will keep a duplicate set of records of material used, time of their workmen and other totally unnecessary information, for the same information is on record elsewhere and is more reliable than the records they keep. If it is really necessary to keep records, the foreman should be given a clerk so that his time could be used to advantage in placing and following up his work.

In order to secure a steady and regular output, the movement of engines should be based on weekly output instead of monthly. The foreman should be given to understand that he is expected to produce, say, one engine a week, and to arrange his work accordingly. By having a monthly output the repairs are liable to drag along until the end of the month and then the entire output will be handled in a bunch, which means the swamping of certain departments. It is easier to plan and carry out work for a period of six days than for 30 days, for when a foreman has the entire month ahead of him, he will neglect small items that soon lead to the retarding of his work. In any shop of medium size, it will be found that the men will plan and carry out instructions for a week ahead far better than for 30 days. It may take some time to bring this plan into effect but the results are bound to warrant the efforts.

There is no doubt that a good shop routing system is the logical method of having work done on a regular schedule, but if there is no such system the general foreman can plan and carry out a schedule. In fact, at nearly every shop, the general foreman is nothing more than a routing engineer, for his duties are to follow up work in all departments and have it completed on schedule time.

FUEL OIL INSTALLATION FOR SMALL SHOPS*

There seems to be a growing demand for a cheap and safe installation of fuel oil devices which can be made at small shops and terminals. The arrangement here submitted, which has been passed on by some of the best fuel oil engineers that we have been able to get an opinion from, is an installation which can be set up by the local forces and will be a guide in establishing a standard installation for



Fuel Oil Installation for Small Shops Recommended by the Railway Fire Protection Association

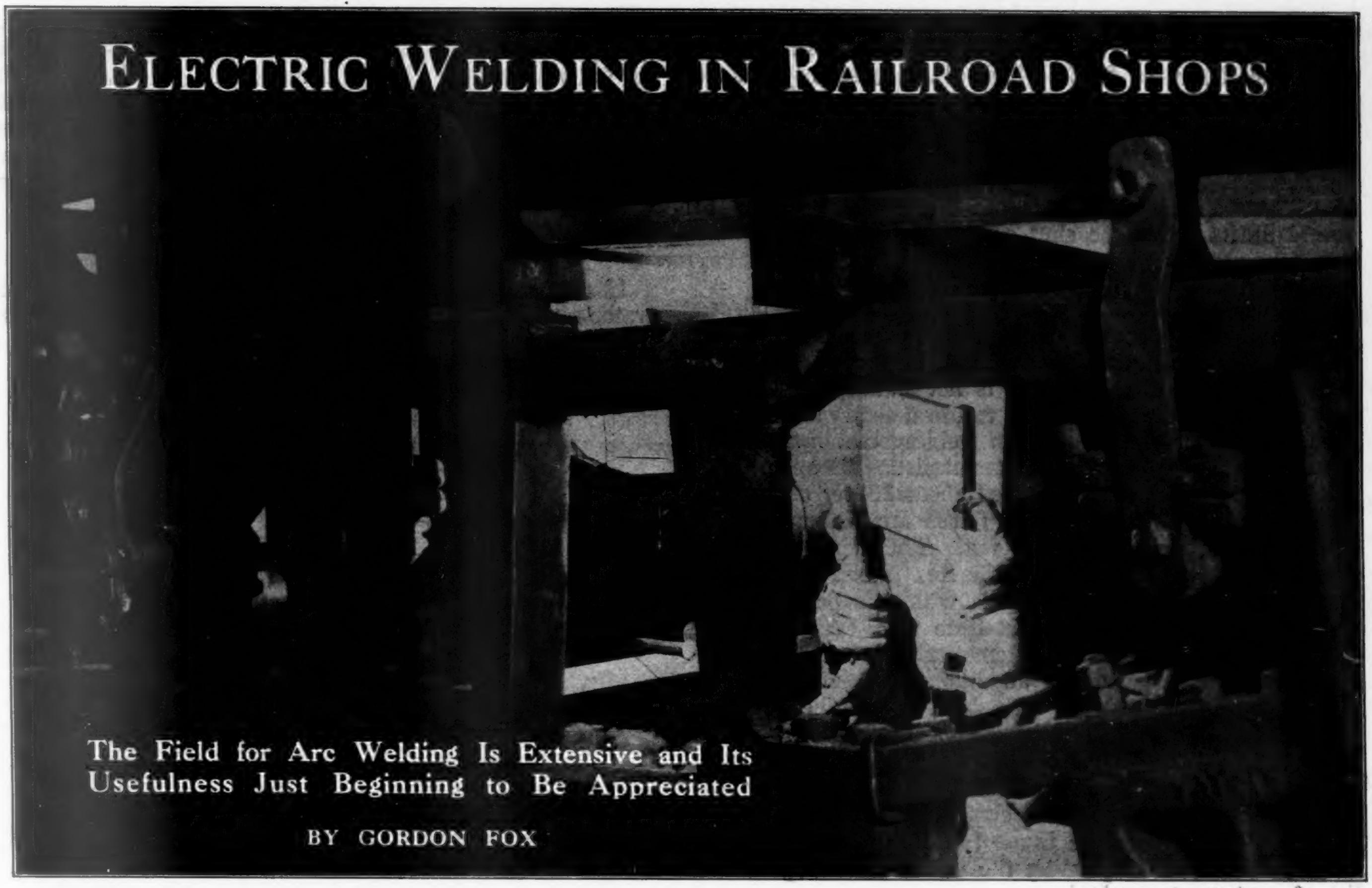
small plants. While the plan contemplates the use of an automatic cut-off valve, which the committee recommends at all times, it can be operated without, provided the tank is installed deep enough in the ground to give the supply pipes a drainage toward the tank. This is a cheap and safe installation and while the plan shown may be changed to suit local conditions, the general scheme should be adhered to.

*From the report of the committee on Oil Burning Appliances, presented at the third annual convention of the Railway Fire Protection Association, held in New York, October 3-5, 1916.

ELECTRIC WELDING IN RAILROAD SHOPS

The Field for Arc Welding Is Extensive and Its Usefulness Just Beginning to Be Appreciated

BY GORDON FOX



Welding a Broken Locomotive Frame by the Metal Electrode Process.

ELECTRIC arc welding is a form of autogenous welding. There is nothing mysterious about the use of electricity for welding, as its function is simply to produce heat, that being the sole reason for its use. In electric arc welding one terminal of a source of direct current is connected to the piece to be welded, the other terminal being an electrode in the hand of the operator. The movable electrode is touched to the article, establishing the flow of current. The arc is drawn by withdrawing the electrode a short distance. If this separation is maintained within moderate limits the arc will continue to flow between the electrode and the object and the heat of this arc fuses the metal at the point of welding.

ARC WELDING PROCESSES

There are two commonly used arc welding processes which are distinguished by the material used in the manipulated electrode. These are most commonly called the carbon electrode and the metal electrode processes, or they may be termed, after their inventors, the Benardos and Slavianoff processes, respectively.

In the Benardos method the electrode manipulated by the operator is a carbon pencil which varies from ½ in. to 1½ in. in diameter and from 6 in. to 12 in. in length. The size of the pencil used is varied to suit the nature of the work. Special pencils for arc welding may be secured from carbon manufacturers, they being preferably of graphitic carbon which has high thermal and electrical conductivities. The carbons should be uncored. Long pencils are generally clamped near the working end in order to shorten the current path and reduce the internal resistance; as they wear away the clamping position is changed. The pencil should be ground to a point and should be maintained fairly sharp in order that the position of the arc may be controlled. With round ends the arc has a tendency to travel, especially if there be any movement of air. The carbon is clamped in a light weight, insulated holder having a shield in front of the handle to protect the operator from the excessive heat.

The arc welding process involves the heating of the object to the proper degree, followed by the feeding in of molten metal of proper characteristics to join the parts, to fill the holes or to build up the surface, as desired. This filling material is usually introduced by melting the so-called filler rod under the arc. For wrought iron or steel, various filling materials, ordinarily Norway and Swedish iron, may be used. Bits of steel castings, boiler iron or scrap are sometimes used in place of filler rods. For cast iron, either of the above rods may be used or copper wire or special cast iron filler rods high in silicon may be best suited. A high percentage of silicon in the filler rod tends to give soft metal at the weld. The filler bar should be ⅛ in. to ½ in. in diameter, depending upon the nature of the work. Rods of ¼ in. diameter are good for average jobs, and those about 3 ft. in length are as long as can be conveniently manipulated. Short rods and small bits are harder to use since they cannot be readily seen by the operator.

OPERATOR'S HOOD

The electric arc is of intense brilliancy and injurious to the naked eye when viewed from some distance. Close at hand it is practically blinding. It therefore becomes necessary to equip the operator with a screen or hood. A window is provided, in which several thicknesses of red and blue glass are used to cut down the light and screen out the violet rays. Any dark glass should not be used as only properly selected glass will thoroughly protect the operator from eye strain. The glass used is so dense as to be nearly opaque toward ordinary daylight, but after the arc is struck, the operator can see his work quite readily. The rays of the arc have an effect on the skin similar to sunburn. Heavy gauntlet gloves and fairly heavy clothing should therefore be used; and the screen or hood must be kept in front of the

face to prevent rapid sunburn. Suitable screens and hoods can be purchased or easily constructed, and in selecting them one should be found which allows easy inspection of the work by lifting or swinging the window carrying the glass. It is desirable that, where possible, arc welding be done in an enclosure so that passers-by will not be blinded by the light, which may thus contribute to a possible accident. Also, since the arc is sensitive to air currents, all severe drafts should be shut out.

MATERIAL AND EQUIPMENT USED

The use of a flux is somewhat optional. The purpose of a flux is to protect the surfaces from oxidation, and some welders are emphatic believers in it, while others see no benefit from its use. Practice is not standardized in this respect. It is hardly necessary to use a flux when welding wrought iron or steel, but when welding cast iron the use of a flux may be generally recommended. Borax makes a good flux to which may be added about 20 per cent of red iron oxide. Many commercial fluxes are obtainable, and all may be used either dry or wet. The most satisfactory results are obtained by mixing the flux into a paste, using water, and coating the filler rods with this paste. Filler rods may be purchased in this form also. As such rods melt the flux is introduced automatically.

The arc welder who has any large volume of work to perform, particularly upon cast iron, should be provided with a suitable preheating and annealing furnace which may be heated by oil, gas or charcoal. Its use is almost imperative for many jobs on cast iron. Aside from the furnace, some fire bricks, fire clay and asbestos for molding and damming, a wire brush for removing scale and a machine hammer for peening the new metal complete the list of equipment required.

CURRENT USED

The electric power must always be direct current. For carbon electrode work, about 35 to 50 volts is required across the arc, the exact amount varying with different classes of work and different arc lengths used by the operator. It must be possible to short circuit the arc without causing

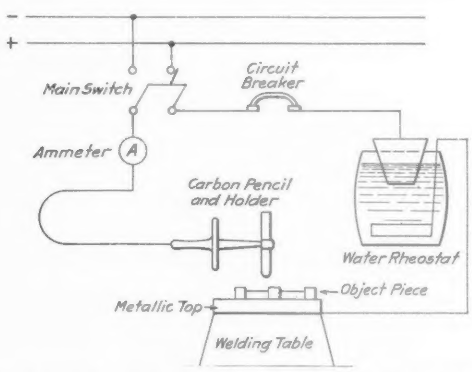


Fig. 1—Diagram Showing Use of a Water Barrel Resistance

too severe a rush of current in the feeder circuit. In the Benardos process the current required depends upon the nature of the work, amounting to about 300 to 400 amperes for average service. Thus about 15 to 20 kw. of heat is liberated at the arc for heating the metal.

If power is taken from 110-volt or 220-volt or even 550-volt power lines, resistance may be inserted in series with the arc to reduce the voltage to the desired value. This resistance serves a double purpose in that it cuts down the arc voltage and, at the same time, prevents a heavy short circuit current when the electrode is held in contact with the object previous to drawing the arc. Water barrels or rheostats may be used for this purpose, as shown in Fig. 1. Grid resistances are superior to water barrels in that they are more portable and may be worked hard without giving trouble such as is experienced due to boiling over of water rheostats. For the occasional job, however, the water rheostat is as satisfactory as the expensive motor generator set, except that with its use the cost for current is greater. The wiring diagram illustrated in Fig. 2 shows the connections of an electric welding outfit using grid resistances.

MOTOR GENERATOR SETS

If alternating current alone is available, a motor generator set is a necessity. Such a set is also of value where the direct current is at 115 volts or higher and where a

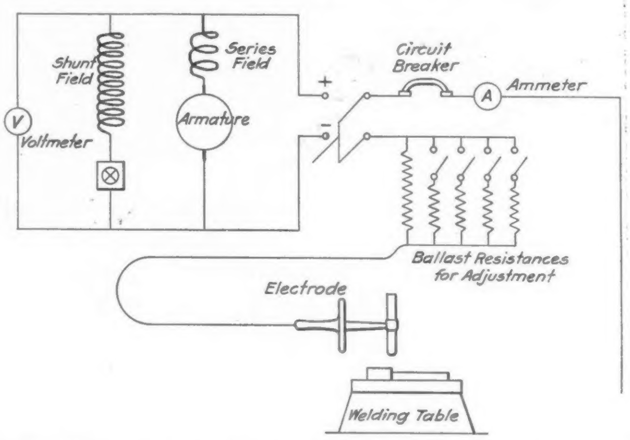


Fig. 2—Diagram Showing the Connections for a Welding Outfit Using Grid Resistances

considerable volume of work is handled, as there is considerable power lost in reducing the voltage from 230 to 50 volts by resistance. The purpose of a motor generator set is to transform the available power and deliver it in the form best suited for the welding. In a straight direct current set the only object is to save power. The justification of the investment depends upon the amount of welding work done, the character of the work, the voltage of the supply and the cost of power. Where the only available power is alternating current, a motor generator set is necessary since arc welding with alternating current can be done only with the greatest difficulty.

Two distinct types of motor generator sets are available for arc welding, different manufacturers championing different systems. In one type the current is delivered at an approximately constant pressure of 75 volts and an adjustable resistance is used in series with the arc to vary the arc voltage to suit the work in hand. The connections for the generator of such a set are shown in Fig. 2. This type of generator is particularly adapted for installations where several welders will work simultaneously. Under such conditions each welder adjusts his arc by means of an individual resistance bank on a small panel furnished for each outlet. Several welders may draw power from the same motor generator set, yet be entirely independent of each other. This type of machine does not eliminate all the resistance losses, inasmuch as the reduction from 60 volts to arc voltage is represented by resistance loss. The sets of this type which are on the market are normally capable of handling a single large carbon arc or several smaller metallic arcs simultaneously.

The second type of motor generator set is a so-called constant current or variable voltage equipment. In this system the generator delivers a variable voltage, maintaining an approximately constant current flow. For instance, when the electrode touches the object in striking the arc, the voltage is nearly zero, and as the electrode is drawn away, the voltage increases with the lengthening of the arc. A

machine of this type delivers automatically the desired voltage to maintain an arc of desired intensity. It is therefore effective in affording constancy and uniformity of the arc and, inasmuch as no ballast resistance is required, this system is more efficient than the previous one. Sets of this type are commonly built of proper size to handle a single metallic arc. Obviously, such a set can feed but a single arc since, with more than one outlet, the requirements of two welders would interfere. When carbon arc welding is to be done, two or more sets are paralleled to supply the required capacity.

WELDING WITH THE CARBON ARC

In the Benardos process it is necessary that the piece to be welded be connected to the positive side of the system, the manipulated carbon being the negative side. In a direct current arc the greatest energy absorption, therefore the highest temperature, occurs at the positive electrode. This may be explained by the theory that the metallic vapor in the immediate vicinity of the positive electrode is of higher resistance than that near the negative electrode. When the metal to be welded is made the positive electrode, melting should be more rapid, since the greatest heat is developed at the metallic surface. As iron and steel are more readily vaporized than carbon, with the metal the positive terminal, a greater quantity of metallic vapor is carried into the arc. This vapor has greater conductivity than carbon vapor and maintains the arc more steadily. Also, if the carbon were the positive terminal, the arc stream would carry carbon particles and vapor into the weld, making the metal hard and brittle.

In making a weld with the carbon arc, the piece to be welded is laid upon the metallic welding table in such a way that a good contact is secured. The point of welding should preferably be on top, as it is much more difficult to weld upon the side of an article than upon its top surface. Welding upon the under side of pieces cannot be accomplished by the Benardos method and can be done only after much practice with the Slavianoff method. If a large piece is to be welded it may be more convenient to simply clamp the positive lead to it at some point.

Preparation of work for welding by the carbon arc consists mainly in thoroughly cleaning the surfaces to be welded. In most cases this can be done by turning the work edgewise or inclining it and then going over the surface with the arc and melting off all surface impurities which will run off by gravity, thus leaving clean metal. The same procedure can be followed where two pieces are to be joined, the arc being used to melt the edges of the sections to be joined so as to provide a V-shaped groove at their junction, thereby insuring that the entire joint is filled with perfect metal. Where thick sections are to be joined, it will often be found advisable to cut a groove from both sides to the center of the section. In any event it is essential that the groove extend entirely through the junction.

At the beginning of the work the arc must reach the bottom of the groove and liquefy that point first. It is impossible to reach the bottom of a narrow groove since the arc will jump to the sides. A double angle of about 90 deg. is therefore necessary. If a crack is to be repaired, it should first be recessed either by using the arc as just outlined or by chipping a V-shaped groove in it. When two pieces are to be welded together they must be first alined and clamped together or to a third piece. If a one-sided heat is to occur, some allowance must be made for unequal contraction. This part of the work calls for experience. If it is desired to build up new metal to any height, a mold must be made to retain the molten material which may be made of asbestos or fire clay.

The preliminary work being completed, the welding may be started. The resistances are adjusted to the estimated proper values, the operator touches the carbon to the object and draws his arc. The arc should be made fairly long, particularly at the beginning of the work. A long arc increases the energy and heating, and at the same time distributes the heat better. A very short arc hisses and is likely to produce a hard, brittle weld. The proper length of the arc depends upon the size of electrode and nature of the work, but may be from one inch to over two inches. If the arc cannot be drawn to this length there is too much ballast resistance. If the arc is too fierce and the current too high, the ballast resistance is too low. It is well to use an ammeter always so as to observe what current is most effective for different kinds of work. By remembering previous conditions it will be possible to always work under the most favorable conditions.

The arc is moved with a rotary motion from one side of the piece to the other in order to distribute the heating uniformly over the zone to be welded. When melting temperatures are reached the arc is confined more to the center of the groove and the filler rod is brought into play to start filling in, care being taken to see that the new metal adheres and flows into the metal of the side walls. As new metal is added the groove is filled and the point of action is moved forward. The arc is kept in motion all the time, however, a circular swing being most effective. If flux is used for the work and this is not supplied in the filler rod it may be shaken into the weld from time to time, a can with perforated cover forming a convenient means. As soon as the weld is completed the electrode is laid aside, the hood removed and the new metal given a thorough peening to make it more dense and improve the grain. The work of welding should, if possible, be done in one continuous heating in order to prevent formation of oxide and for other reasons. A heavy piece may be welded from two sides, in which case each side would be hammered before turning over.

WELDING WITH THE METALLIC ARC

The metal electrode or Slavianoff process is, in most respects, quite similar to the carbon process. Instead of the carbon pencil a smaller metallic pencil is used which also forms the filler rod; it melts away and enters or builds upon the object as the welding progresses. A lower voltage and shorter arc are used for this method. The arc is only about 1/8 in. to 3-16 in. long, while the voltage at the arc is about 18 to 30 volts. The current used will be about 90 to 200 amperes, according to the size of the pencil and the character of the work. The pencils are from 1/8 in. to 1/4 in. in diameter and about a foot long. A small, light holder is used, being arranged to grip the pencil through a cam or other clamping arrangements, so that new pencils may be quickly inserted as the old ones are consumed.

Preparation of work for welding done by the metal electrode arc is in most respects similar to that for carbon arc work. For many classes of work, in fact, the carbon arc can be used to prepare the work for repair by the use of the metallic arc. The first essential is that of absolute cleanliness of the work, all traces of oil, scale, rust, etc., being thoroughly removed before welding is begun. Where flues are to be welded to flue sheets in locomotive fireboxes, this cleaning can be very satisfactorily done by use of a sand blast which, if properly used, leaves the flues and sheets in condition for welding without further preparation.

Before attempting to repair work such as cracked firebox sheets, broken frames, etc., it is necessary to provide space for the metal to be added, just as is the case with the carbon electrode process. Where a crack is to be repaired the sheet should be cut along the line of the crack, into a V-groove with an angle of about 90 deg., the sheet being cut entirely through and the width at the bottom of the groove being approximately 1-16 to 1/8 in. The cutting may be done either by a chisel or by first using the carbon arc to

cut the groove, then using an air chisel to clean up the sides and remove all of the melted surface.

Where welding is to be done in a vertical plane as would be the case where vertical cracks are to be repaired on firebox side sheets, or the vertical sides of a patch in the firebox, the welding should be begun at the bottom of the groove. The metal added is then built up on top of that previously deposited, and with reasonable care sound welds are assured.

In filling in cracks, welding patches, etc., practice differs as to whether to fill the entire groove at one application of the arc or whether to first fill the bottom of the groove and later add enough metal to finish the weld in a second course. Either method should give satisfactory welds providing proper care is taken by the operator to assure a thorough junction between the sheets and the new metal. Where welding is done in more than one course, care should be taken to see that all particles of oxide or slag are removed from the surface of the preceding course, as well as from the edges of the sheet. This can best be done by the use of a stiff wire brush.

Where long seams are to be welded, as for example, in welding in a half side sheet, practice again differs as to the best method of taking care of expansion. Some operators prefer to allow for expansion by widening the gap between the sheet, this being done by setting the new sheet away at a slight angle; the allowance usually made by these operators is about 1/8 in. to 1/4 in. per foot of length. Then when the weld is begun at one end and the work is carried on, the two edges will gradually draw together, due to the contraction in the weld at cooling. Other operators prefer to place the two edges in final relation to each other, holding them at the proper distance apart by means of "tacks" at intervals of 12 in. to 18 in. The weld is then begun at either end and as it approaches a "tack" the tack itself is cut out by use of a chisel and solid metal welded in, the tack simply serving the purpose of holding the sheets in proper relation until the weld is made. When tacking is used, it has often been found advisable to weld a short space, say six or eight inches, from one end of the seam, then go to the other end of the seam and weld a like distance, thus keeping heating and expansion at a minimum.

In any event, troubles from expansion will be found at a minimum where the metal electrode arc is used as while the heat at the weld is very intense it is also very concentrated so that the total heat tending to expand the metal surrounding the weld is a minimum.

The object is commonly made the positive terminal, as in the Benardos method, although it is possible to reverse this relation with quite satisfactory results. Reversal of the connections causes the metallic pencil to become the point of greatest heat so that it melts away quite rapidly and may deposit upon the object when the latter is too cool. Reversal of connections, however, may be convenient in some cases, as, for instance, field work in an electric traction system where the power is taken from the trolley. Under such conditions, if the object is made positive, careful insulating arrangements are necessary. If worn frogs or crossings are to be built up, the object is of necessity the negative terminal.

Since the metallic arc is less intense than that with the carbon electrode, the hood may be dispensed with, but a screen is still required and gloves must be worn. The material for the filler rod may be Norway or Swedish iron or Bessemer steel. The first mentioned is recommended. Pencils coated with flux may be purchased, otherwise flux may be shaken into the weld from time to time. Little flux need be used when welding by this method.

The process of welding with the metallic electrode is much like that using the carbon electrode, but since the arc is so short, a steady hand is required to maintain it. A little withdrawal of the pencil causes the arc to go out, while touching the object piece may cause the pencil to adhere. Supporting the arm helps to keep the hand steady. The pencil and the point of application should both be molten simultaneously and the movement of the pencil and length and intensity of the arc must be adjusted to obtain this condition, otherwise a good weld is not secured. Lengthening the arc slightly increases the heating at the piece. Inasmuch as metal is being constantly melted off and deposited, the pencil must be kept in gradual progression to prevent piling up of the metal in one spot. It requires considerable practice to obtain the right heat and right deposit simultaneously. A weld made by the metal electrode process does not usually require hammering as the grain is found to be closer and better than when the carbon electrode is used, but a little hammering does no harm, if done while the weld is still at red heat.

ALLOWING FOR EXPANSION

The process of melting and filling in the metal does not comprise the entire art of welding, as properly allowing for expansion, contraction and warping is a most important feature. In the case of castings particularly, difficulty is sometimes experienced due to cracking while the piece is cooling. The crack is most likely to occur at the weld, although pieces not infrequently crack at an adjacent point. Cracking may be caused by poor welding due to dirt or oxide or carbon from too short an arc, but it is more likely due to the shrinkage stresses incident to cooling. Any piece is larger while hot than when cold, consequently if a portion of a casting is hot and a portion cold it is easy for great strains to be set up. Cast iron will withstand little tensile stress, hence it cracks as the stresses incident to shrinkage are of great magnitude. To avoid shrinkage stresses is part of the art of welding, and considerable study may be given to this feature. Shrinkage troubles may be materially relieved if the casting is brought to a red heat before welding; then, after the work is completed, it should be allowed to cool slowly in the furnace or buried in lime or mica dust. Slow cooling is also necessary to secure soft metal in cast iron work. If an ordinary casting, when poured, is allowed to cool quickly, it becomes chilled iron, hard and brittle, likewise the cast metal flowing into a weld will become hard if cooled rapidly. It is easy for a weld to be chilled quickly as there is heat conducting metal all about it which will rapidly absorb its heat; hence the desirability of annealing.

TEMPERATURE OF THE ARC

The temperature of the electric arc is estimated at 6,300 to 7,200 deg. F., it being the hottest flame known. The arc is therefore applicable to the melting of all metals. In practice, however, electric arc welding is most effective for work on wrought iron and steel. Welds in cast iron are not always dependable, and may be hard if carbon is allowed to enter the metal from a short arc or if the piece is chilled. Malleable iron, which is malleableized white cast iron, cannot be dependably welded by any process. When welded it loses its malleability because of the heating and filling, and returns to its original state as white iron, hard and brittle. The electric arc is also ill-suited for welding brass and bronze as it is too hot and vaporizes portions of the alloy.

STRENGTH OF WELDS

The strength of electric arc welds is usually about 70 per cent of the strength of the metal, assuming that cast steel is being welded. With machine steel the weld should be of 80 per cent efficiency. The metal which goes into the weld is really in cast form, although its grain may be improved by hammering. In many cases the strength of the weld is not of prime importance, as when filling holes, building up worn surfaces and similar work, but if the strength of the weld is important it is often possible to make up in quantity of metal what is lacking in quality by building on extra

metal at the weld and over the adjacent section. Metal may be added or built on by the arc process with impunity and to a nicety.

BENARDOS VERSUS SLAVIANOFF PROCESS

Each method of arc welding finds its advocates. The Benardos process was originally most used, but the Slavianoff process is probably more popular at present. The Benardos process affords greater heat volume and is best suited for heavy work where speed of application is desirable, and where the quality and finish of the weld are of secondary importance. The Slavianoff process usually gives a more reliable weld, gives finer texture to the metal, leaves it less porous, can be more neatly executed and finished, requires less power and may be easier controlled. The Benardos process is well suited for filling holes in large castings and similar work, but the Slavianoff process is best for building up metal on surfaces since the addition of metal is largely automatic and the confinement of the heat avoids flowing and run-off tendencies; in other words the added metal stays where it is put. With suitable control provisions, it is possible to combine methods, heating the working zone by the use of the carbon arc, and building up the new metal with the metal electrode, the procedure depending upon the character of the work and the ability to reach the molten condition simultaneously upon object and electrode.

FIELD FOR ARC WELDING

The field for arc welding is extensive and is rapidly widening as the usefulness of the process becomes realized. It is particularly well suited for repair work, as it is flexible and adaptable. In the railroad shop arc welding is extensively used for welding breaks in locomotive and car frames, the work being done with a minimum of dismantling. Worn parts are frequently built up by the addition of new metal. Arc welding has been successfully used for the building up of flat spots on steel driving and car wheels, which avoids the life reduction incident to turning down the entire wheel. Welding the ends of flues is being recognized as superior to beading or expanding. This work is done with the metal electrode. In addition to these specific applications many individual jobs of all sorts are subject to advantageous handling by this method.

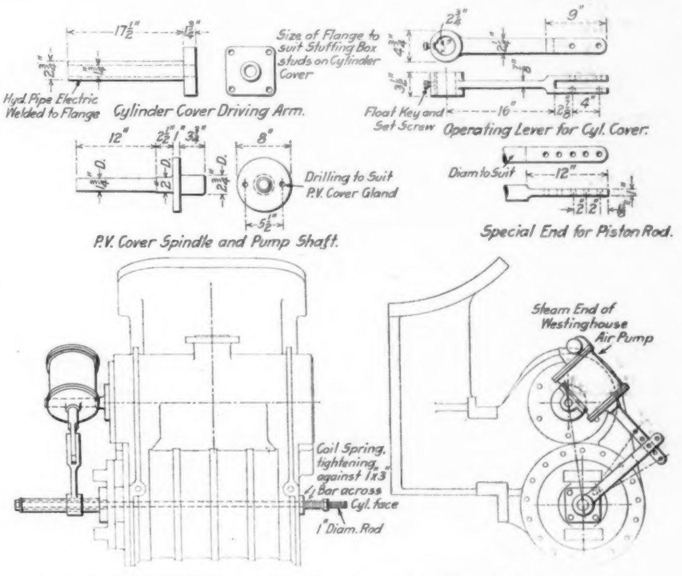
In flexibility or character of workmanship the arc process is not superior to the oxy-acetylene flame; in fact the gas process is more flexible and is considered by some workers to be better upon cast iron. For work on brass, bronze or aluminum the oxy-acetylene flame has no competition. The acetylene flame is also somewhat easier to handle as glasses alone are required, no hood or screen being necessary. The main point of superiority of the arc method is its economy, as the electric arc produces the necessary heat at a much lower cost than does the oxy-acetylene flame. In its field the arc also produces results as good, if not better, than can be obtained with gas, i. e., flue welding. To avoid excessive cost, preheating is almost always necessary in gas welding, but may often be dispensed with in arc welding. The cost of electric power for a welding job will only be from 15 to 25 per cent of the cost of oxygen and acetylene for the same job.

TYPES OF ELECTRIC FURNACES.—Different types of electric furnaces, whether for laboratory or for commercial use, may be classified according to the methods employed to transform the electrical energy into heat in the material. These are: By passing the current through the metal to be treated, so that the metal forms a part of the circuit; by passing the current through a resistance material, the heat thus produced being radiated and conducted to the metal; by surrounding the metal with an alternating-current circuit, so that eddy currents are produced in the metal, these currents generating the necessary heat.—*American Machinist.*

CYLINDER HEAD GRINDER

BY J. LEE

The cylinder head grinder illustrated consists of seven pieces; a cylinder cover driving arm, a piston valve cover spindle and pump bearer, an operating lever, a steam end of a standard 9½ in. Westinghouse air pump with a special rod fitted, a long 1 in. rod, a coil spring, and a bar 1 in. by 3 in. To grind in a cylinder head, the stuffing box glands are removed and in place the driving arm and pump bearer are bolted on, the piston valve cover of course being securely bolted in place, and the cylinder cover being free to turn.



Cylinder Head Grinder Made from an Air Pump Cylinder

The driving arm is hollow to allow a one inch rod to pass through. This forms a means of applying pressure between the cylinder and cylinder cover faces, the nut on the rod screwing up to a coil spring which is supported by a bar placed across the cylinder face. The piston rod and operating lever are connected as shown, and the arrangement is then ready to operate.

ENGINEHOUSE PRACTICE*

BY J. F. DONELLON

To be a successful enginehouse foreman, a man must be able to perfect an organization that will take care of every detail. The foreman who trains his mechanics to be specialists will be more successful than the man who permits every Tom, Dick or Harry to set valves, file brasses, line guides, etc. Most enginehouse foremen select their best men for passenger engine work, and if these men are properly trained they will take a personal pride in the performance of engines, and the engine failure sheet will be blank so often that when there is a failure it will give everyone the blues.

The best way to avoid engine failures is to have a 100 per cent. organization, locomotives as nearly as possible of one class, and get all the men interested. The latter can be done by telling them of some failure that was just barely averted by the quick action of the engineman, the cause being careless work or inspection, and by posting the engine failure sheet in a conspicuous place, so the shop men can read it. They will become familiar with the petty defects that cause engine failures, as well as the break-downs, will make every effort to tighten up on their inspection, and do better work.

There should be a machinist assigned to take care of piston rod and valve stem packing, keep oil swabs in condition

*Entered in the Engine Terminal Competition.

on both piston rods and valve stems, keep guide oil cups in good condition, and report the condition of the guides.

In a good many engine houses guide cups are given very little attention, especially on pooled engines. Some are in service with tops missing, allowing sand and grit to partially fill the cup. This results in the babbitt metal on the cross-head wearing out very quickly.

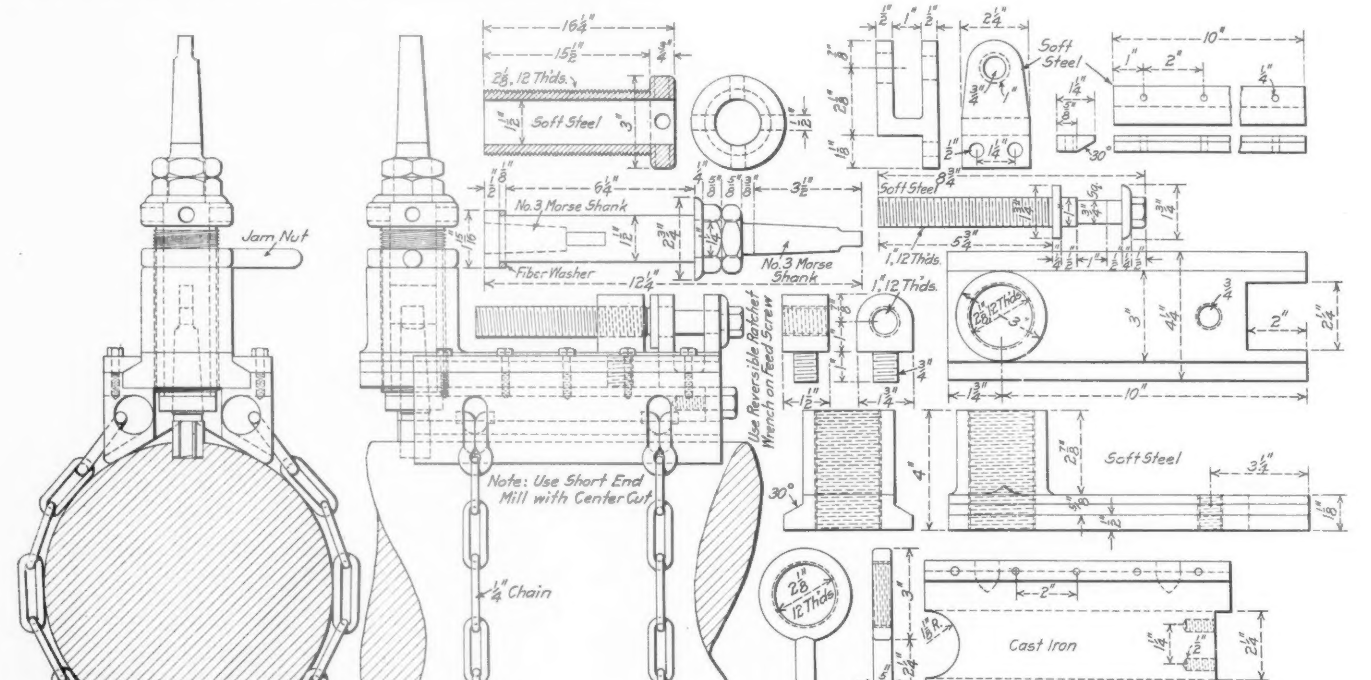
There should be a regular man assigned to reduce or refit main rod brasses, especially on passenger engines. Enginemen as a rule are very finicky on this point, and if a good, reliable man reduces a main rod brass it gives the engineman greater confidence, with the result that he makes a better run.

Alongside of the inspection pit there should be a tool house where the supply men, after removing all tools from the engine, can store them until the engine is called. While the engine inspector is inspecting the engine, the man who fills the grease cups is doing his work, and the man who looks after head lamps and classification lamps is busy performing his duty, so that when the shop men have finished the engine-house repairs, all that is necessary to be done is to equip the engine with tools and supplies.

ECCENTRIC KEYWAY CUTTER

BY E. A. MURRAY
Master Mechanic, Chesapeake and Ohio, Clifton Forge, Va.

The machine shown in the drawing overcomes many of the difficulties which were encountered in drilling and chipping out keyways in axles. It consists of a cast iron base which is clamped to the axle by means of chains and set screws. This base carries and guides a support and guide for a short end mill. The support is made of soft steel, with a soft steel bushing for the mill socket, which has No. 3 Morse taper for both the mill and the driving motor. The mill is moved by means of a horizontal feed screw, attached to its support and adjusted by a reversible ratchet wrench.

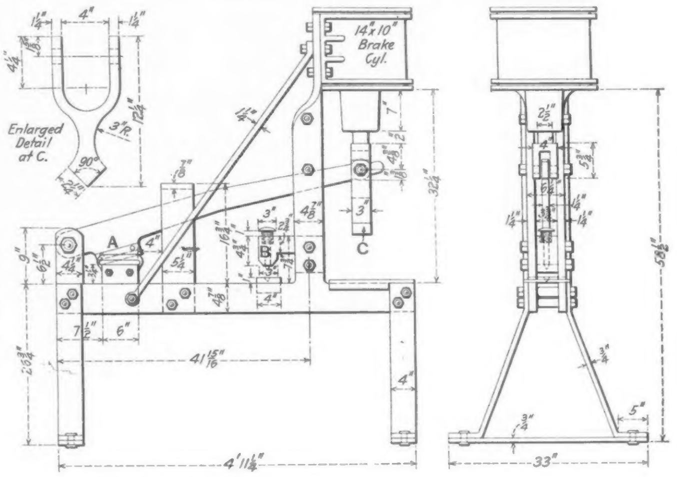


Machine Used on the Chesapeake & Ohio for Cutting Keyways in Axles

COMBINATION PNEUMATIC SPRING SHEAR AND BENDER

BY J. H. CHANCY
Foreman Blacksmith, Georgia Railroad, Augusta, Ga.

The illustration shows a combination pneumatic shear, punch and bender which has been recently constructed for use in the spring making and repairing department. It is



Details of Spring Shear and Bending Machine

located conveniently to the spring maker's fire, and is used for turning the ends after they have been tapered at the shear *A*, and for cutting old plates that are often reclaimed. The punch shown at *B* is used for titting the springs and the plunger *C* is used for bending them. The arrangement is made up from material that may be obtained in any shop, a 14-in. by 10-in. air brake cylinder being used for the driving medium. This machine has saved time in spring work.

TRAINING YOUNG MEN FOR PROMOTION*

Santa Fe Method of Picking and Training Recruits for Its Future Mechanical Department Officers

BY F. W. THOMAS

Supervisor of Apprentices, Atchison, Topeka & Santa Fe, Topeka, Kans.

THE training of young men for positions of responsibility involves two considerations; the foundation upon which to build and the material with which you are to build. The solution of both of these by the Santa Fe requires a little explanation of the preparation of the raw material from which we may select the stones for the building. Our apprentice system was organized nine years ago and developed along the lines promulgated by G. M. Basford. We do not claim the credit of originating the scheme. We do, however, claim the honor of having put his idea into practical effect, standing by the scheme and backing it up until the infant could stand alone, and today we are reaping some invaluable results—results you cannot measure in dollars and cents.

THE APPRENTICE SYSTEM

Briefly, our scheme for training boys for our shops, is as follows: We take a boy who has completed grammar school or better and examine him as to his mental make-up. A series of simple arithmetical problems, coupled with the manner of filling out his formal application blank, and a personal interview, give us some idea of the boy's accuracy, industry and alertness. He then goes out in the shop to run the gauntlet of our shop instructors. They find out why he wants to be a machinist instead of a lawyer, or a boiler maker instead of an editor or preacher, if some friend or parent simply sent him to us on account of the good wages paid mechanics, or if he is making application simply because his father was a machinist. We want to find out as much as possible about the boy from the boy himself. We do not ask any letters of reference. We do, however, strongly endeavor to get boys of good, honest parentage. If he passes the shop instructors he next goes to our surgeons and passes a physical examination. We are taking these young fellows in our service for life, and it is well that young men sound in body and mind should be selected.

If the doctor passes him the boy goes to the office of the superintendent of shops, filling out the regular indenture papers and minor's release, is given a letter to the shop foreman, who gives him a shop number, etc., and he is told to be on hand by the time the whistle blows in the morning. He enters the shop next morning. He is not left to wander around or to wait for someone, or to be bewildered by a sea of strange faces, or frightened by whirling belts, moving machines, or unaccustomed noises. The shop instructor meets him, a kindly hand grasps his, a kindly face is looking upon him, a kindly voice is speaking to him. Then a feeling creeps over him: "What a glorious and good world this is"—an exhilarating feeling which each of us has felt the hour we began to work for ourselves.

The apprentice in the shop is constantly under the eye of the shop instructors and is taught how to perform each operation or step of the trade he has been indentured to learn. An exact account is kept of each job performed and the time required to perform it. His shop work is correlated with useful instruction in the apprentice school room. We teach him mechanical and free hand drawing, the elements of mechanics, shop arithmetic, and some other subjects, closely related to his actual shop work. A boiler maker apprentice, for instance, will have acquired a working knowledge of plane and descriptive geometry. He will be able to give you an intelligent definition of a boiler, the correct name and function of each part. He can calculate the strength of any kind of seam, can figure out the factor of safety of a boiler or any part of it; from a flat sheet he can lay out, mathematically or geometrically, any section and develop it. He is familiar with the Federal rules as to the inspection and maintenance of boilers. He can quickly make you a sketch or a working drawing of a boiler, can lay out, flange, stay, and build a boiler. At 21 ~~years of age he is the equal of~~ a boiler maker of 50 years. Throughout his four years apprenticeship he is hourly watched by general and shop foremen, by shop and school instructors. His weak points are strengthened, his strong features are exercised. Personal characteristic blanks are filled out from time to time which give the supervisor's office a graphic personal record. While the boy is serving his apprenticeship we find out his particular fitness, firmly convinced that the boy, now a man, will perform his duties better when his heart is in the work; if he can be placed on a class of work which he loves, he will certainly do better than if engaged on some work which he does not like.

RECRUITS FOR PROMOTION

The best worker will not necessarily make the best foreman, this we have long since learned. Those who have given evidence of possessing talent for leadership are selected for development. Possibly and very probably not all deserving ones are selected, but we are pretty sure that only those are selected who have given evidence of such ability. This is our first source of supply. The second is from our special apprentices, who are graduates of engineering schools.

Special apprentices are selected only upon a personal interview. We cannot put much credence in letters of recommendation from professors or influential friends. I do not mean by this that they attempt to deceive. The trouble lies in the fact that they are not really and fully acquainted with the young fellow. There is little or no effort made by our college instructors to find out the real natural talent of the student. We require these specials to work one year on machines, and one year on erecting floor, then we decide whether or not he shall pursue our course for the development for positions of responsibility.

We now have the boy from the public schools who has served his four years journeyman apprenticeship and has become a first-class mechanic, and the college man who has engaged in practical shop work for two years; the pick of two sources for development into our future officers. They must, during their apprenticeship, have been quick to learn, industrious, prompt, honest, readily and effectively amenable to discipline, steady under fire, and popular with officers and associates, and then have some distinctive qualities of leadership.

TRAINING FOR FUTURE RESPONSIBILITY

We offer each of them the following opportunity: He must serve two months in the boiler shop, familiarizing himself with tubes, stays, patches, front ends, Federal laws, etc., pursuing a course of reading and study of boilers and appurtenances. He next goes to our freight car shop and serves

*Abstract of a paper presented before the New York Railway Club, October 20, 1916.

two months on trucks, draft gears, body, doors, roof, air brakes and inspection, also pursuing a course of reading and study on car work, M. C. B. rules, etc. Then we send him to a busy roundhouse for four months. He may previously have had roundhouse work but he is now taught the operation of an engine house from the time a locomotive reaches the ash pit until it is headed out on the "ready to serve" track. Cleaning fire, fueling, watering, actually repairing, the handling and distribution of work orders or slips, dispatching, and the various reports made out by the foreman, etc. Here he reads or studies some good books on locomotives. We next find him with the travelling engineer, studying fuel economics, learning to fire, to inspect and operate the engine, to make out the usual road foreman's report, accompanied by an individual study of parts of the machinery, the construction and operation of injectors, lubricators, safety valves, air brake, valve motion, etc. He also familiarizes himself with the Federal and company rules for the inspection and care of locomotives. We next find him at the front door of our back shops or a large roundhouse, for thirty days engaged in inspecting incoming locomotives and thirty days inspecting outgoing locomotives. Once a month he has written a letter covering the work he has done, explaining the operation of certain features, offering suggestions as to shop management or methods, and criticizing local existing conditions when he can offer some remedy. In each branch of the above he must answer 150 questions bearing on the work in hand.

This is called our Special Course For Graduate Apprentices, and it keeps them terribly busy. They are the very busiest young men I know. We have so made this course that it is a trying and severe one, but it is certainly a developing one. A few break down under it or throw it up, but 80 per cent or over pursue it to the end. We do not expect that the two months in the boiler shop will make a boiler maker but we do know it gives an insight into boiler work which will be of vast benefit to the young man when he is made a roundhouse or shop foreman. We don't expect him to become a proficient car carpenter in 60 days, but he has derived sufficient knowledge of cars, car repairing and inspection, and M. C. B. rules to be not entirely dependent upon the car foreman's word or opinion, and so on through the course. It is surprising how much these bright young mechanics can pick up and assimilate of the other trades during that short period. The course of reading, study, and examination questions does not leave much time for the movies, even his best girl will suffer. But we are making men.

The Good Book tells us that God spent nearly the entire week in creating the entire animal, plant, and vegetable life of the world, before He made man. While we have spent nine years in organizing and building up our present apprentice system, it has been less than two years since we have attempted to specifically train men for our future mechanical officers.

OPPORTUNITY FOR OUTSIDE TRAINING

To prevent any possibility of our growing stale, we pick a number from this list of special course men and send them east. One year ago we brought six machinists and one boiler maker to the Baldwin Locomotive Works for a period of six months, where they were made assistant department foremen. They were given as much responsibility as they could carry and were changed from one department to another every two months. They acquired a general and detailed knowledge of the plant, executive and operative, from the time the material for a locomotive was ordered and received and on through the plant until it left the works a finished locomotive. They had an opportunity to note the practices of nearly all the roads in this country and many foreign nations. They were given, through the liberality of the Baldwin Locomotive Works, an opportunity of visiting a steel mill and studying the manufacture of steel. They were likewise treated with two half days at the Master Mechanics' convention at Atlantic City. I wish publicly to express my appreciation to Mr. Vauclain and his officers for their personal interest and zeal in furthering a scheme which I believe is the best that has been advanced. Every two months the speaker was required to visit these young men in Philadelphia. It is a long way from Kansas to Philadelphia but the Santa Fe believes there is no trip too long or no work too hard, when it comes to developing young men for her service. These young men are back home again. They were not spoiled; they went back to their trade in the shop, but for a few days only. One is fore-foreman of our Dallas terminal, one a roundhouse foreman in Kansas, one in Arizona, one machine foreman in Topeka, one welding engineer in charge of gas and electric welding and one machine foreman in California, all doing well. Seven more have taken their places at Baldwin's.

In like manner we sent four graduate apprentice passenger car men to the Pullman shops to catch on to the latest and best in steel car construction, two young painters to the Pullman shops to acquire the newest and best in painting, graining, and decorating steel passenger cars. Four young fellows are at the Westinghouse Air Brake Company, mastering the manufacture of air brake equipment. The same generous spirit has been shown by the Pullman and Westinghouse companies as was exercised by the Baldwin Locomotive Works. The four car men are back with us, filling positions of responsibility.

Each of the above young men was required twice a month to write me a letter giving in detail their observations and work during the past two weeks. These letters were remarkably interesting and will be of untold benefit to the young men in after years. The training this letter writing gave them could not be obtained so effectively in any other way. It required from two to five days a month for the author to thoroughly read and criticise these letters. The young fellows meet once a week and the letters are read over and discussed by them before sending. No changes are made in the original, though a postscript may be written. It gives each an opportunity of knowing what the other is doing, how he expresses himself, etc.

You may wonder at these details and they may weary you, but they are essential to the subject. You can't go out in your shop and tell your superintendent to make you a foreman in the manner or with the ease he could make an engine bolt or grease cup. You can't pick a horse from the street, send him out to the track and expect him to lead the 2:10 trotters because you have put your bet on him. You would be considered a fool for so doing. If you are going into the racing business you select a horse whose sire has a pure strain of trotting blood for generations back. You go further; you put the colt in the hands of an experienced trainer, who for days and months and years gives him the food which experts have decreed is the right kind, give him the kind of exercise that will best develop enduring wind and fleetness of foot. But you cannot do all this in a day. So we have felt that the material we wish to develop for positions of responsibility must be selected early and trained for five years.

COLLEGE SCHOLARSHIPS

Four years ago I was advised that a Ryerson Master Mechanic scholarship vacancy existed, and the appointment would be made in a few months. We looked over the list of available boys and told two to try for it. One of these won. Last year another was awarded, upon a competitive examination, to a Santa Fe apprentice. We simply told a boy to go after it. This year we had several ready and waiting for the competitive examination and a Santa Fe boy walked away with the prize. We have more getting ready for the next one and will win that one too, so long as a competitive examination rules the selection. This is a by-

plants, and other plants. Is not this the more reason why railroads having such competition should do even more than product of our apprenticeship. It is the result of knowing our boys.

The law is laid down to us that we must not go outside for a mechanical officer. We must promote those who are now in service. The prize is hanging out to them and only when they fail us will we let outsiders enter the race. With this practice in vogue it would be very short-sighted to wait until the job was open to find a man. We believe in having the man ready for the job. We can't have a man ready at a moment's notice unless we are prudent enough to go into the matter a sufficient time ahead.

KNOW YOUR MEN

The weakness, or fitness, of a boy is not left to the judgment of one man. It is the result of four years of individual instruction. There is no such thing in our regular scheme as classes. There is no huddling together boys of all kinds, of all the various dispositions, capacity, and intelligence, each boy from the moment he makes application until the day we graduate him into manhood as a mechanic, is a class unto himself, is treated as a unit, and all the instruction we give him in shop and school room is individual. We go further. We have a governing body known as the apprentice board, composed of our general foreman, department foremen, gang foremen, shop and school instructors, who meet as a trial court to pass on each boy eight times during his apprenticeship. This board is as fair and honest and equally as anxious to mete out real justice as any court or body of men that ever assembled to pass judgment on a fellow man. Religion, politics, poverty, or pull never sway them one iota. If the boy is fit they pass him. If he is a misfit he goes, and no power can save him. Like our courts he may get a new trial. His case may be deferred, but justice will find him. That board is even more anxious in removing the ill-fitted and talentless boy than it is to encourage and help the genius. It is deemed a crime against the railroad, a crime against society, a crime against the boy's young life to require him to stay and attempt to learn a trade when all his talent and all his ambition lies in other channels. When a boy completes his apprenticeship we know him and his capabilities. He may not be a leader, he may not be a world beater, but we know what he *can* do and where to use him.

We have in our apprentice regulations of 22 articles, only two don'ts for the boy. We say he must not smoke cigarettes as the tendency of this practice is towards dishonesty. We say he must not drink for who wants a booze fighter? The other 20 articles are there to safeguard the boy.

When we graduate an apprentice we continue a watchful supervision over him. If he remains at his graduating shop the local instructors keep an eye on him, helping and advising him when necessary. If we transfer him to a distant shop his "follow-up" card is sent ahead to the instructor, who aids him in getting located and in securing a good boarding place, etc., making his first hour in the new town a pleasant one. In fact, the first person a graduate calls to see when entering any of our shops, is the apprentice instructor. He will be assured of one person at that place who will be interested in him. If he leaves the road, we still follow him. It may cost us a few postage stamps but the information is worth the stamps. So we have pretty nearly a perfect record of all our graduates. The location of 150 who have left us is as follows: On adjacent or connecting roads, 57; on distant roads, 14; in Canada, 4; "Somewhere in France," 2; in Panama assisting in operating the canal, 2; in garages, 37; in contract shops, 14; in business for themselves, 12; in the navy, 8.

The first position after leaving the ranks is the most trying of the young man's life. It is here he needs counsel and advice from old heads. We are prone, when entering on a new job, to try to do too much, to turn too many things upside down, to make a record the first month. Right here is where the young man is liable to fail, and a steady, guiding hand is needed to balance him. A master mechanic who had promoted a young fellow to a roundhouse foremanship at an important terminal, told me that for one solid week he spent eight of the ten hours per day in that house. That week made one of the best roundhouse foremen on the system.

An incident recently occurred at Topeka which illustrates the point I am trying to drive home, i. e., knowing your men. The writer makes a monthly report showing number and location of all apprentices, etc. In this report for August was the name of one young boiler maker leaving the service, and the cause of his leaving. Our chief mechanical officer was much perturbed, and called in the superintendent of shops, boiler foreman and his assistant, two boiler shop instructors and the supervisor of apprentices for a conference over this young graduate apprentice leaving the service. I only mention this to emphasize that when such officers can and do spend one-fourth of an entire working day finding out why one young boiler maker had quit, you will find an organization which knows its men and is building for the future.

WHAT APPRENTICESHIP HAS ACCOMPLISHED

We are expecting good results from our apprentice graduates who have won the Ryerson scholarships. These young men had about completed their apprenticeship, are thoroughly equipped in practical shop and machine operations and are thoroughly familiar with the locomotive. They are now at first-class engineering schools. Their technical knowledge will mean something to them.

Our scheme is not complicated, on the contrary it is simple. It has not involved any revolution of our shop management. It has, however, demanded the individual effort of the writer, the co-operation of our mechanical officers, and the moral and official backing of all our executives from the president down. Has the game been worth the candle? Let me briefly recount the benefits we have enjoyed. From our apprentice system we have graduated over 900 first-class, skilled mechanics into our shop forces, trained and educated for Santa Fe work in Santa Fe ways, who in skillfulness, in general intelligence, in resourcefulness, in loyalty, are the superior of any equal body in similar vocations from any railroad or corporation of any place or any time. The present apprenticeship system has improved the whole moral tone of our shops. It has been the means of abolishing rawhiding and mule-driving. The use of profanity by officers to men has practically ceased, and the violation of Rule G is rare.

Of the graduates 72 per cent. are in service today. When you think of the fact that the average turnover of men in the shops and manufacturing plants in the country is three and one-half years, this is a flattering showing. Of the 72 per cent who have remained with us, over 100, or 15 per cent, have been promoted to some position of responsibility and we have others ready and waiting. The past year has been one of unusual activity, the biggest year in our history: more trains moving, more cars loaded, more engines turned than any previous year; yet we have not employed a mechanic from the outside for more than 12 months, and at our principal shops, Topeka, Kansas, no skilled mechanic has been employed for over two years. These are the fruits of our recruiting and training system. Can you beat it?

DISCUSSION

G. M. BASFORD (President, Locomotive Feedwater Heater Company): Several reasons are sure to be advanced to show why the Santa Fe plan will not work elsewhere. Some people think that it will not be satisfactory in a small organization. It is satisfactory in small organizations. Some will say that the labor union limitations on apprenticeship will not permit of such a plan. Is this a reason for not providing for such numbers as the unions do permit? Others will say that the Santa Fe does not have competition with ammunition

the Santa Fe has done to hold their boys? There can be no excuse, no justification, for failure to train men for the future. God help you and your successors if you do not do as the Santa Fe has done. How can you sleep nights until you have started this work? How can you feel sure of your own position until you have done this?

Everything the railroad uses is bought on specifications. It is considered necessary in order to secure what is wanted and what is paid for. But who selects the men? Where do they come from and of what quality are they? Construction work is controlled by specifications, but who constructs your personnel and how is it done? Clerks do the best they can in selecting raw recruits, but is it safe to place this great responsibility upon a clerk? Is it wise to allow him to accept or reject the man who may one day be your president?

Lacking constructive methods of picking recruits, training them and promoting them, it is no wonder that railroad presidents have told me that they did not know where to turn to find the men they need.

In nine years the Santa Fe has laid a grand foundation for the future, but the structure itself is only beginning. In time this great plan will be extended. It will not be complete until it embraces all departments. When this is done we shall not have difficulty in pointing to a truly great, efficient and perfectly balanced organization. Thorough training of well selected recruits is not all the Santa Fe does. It is fruitless to train men unless the organization is prepared to receive the product of the training. The promotion is as carefully handled as is the training. If it had not been, the graduates would scatter promptly. The boys will not quit if they can be shown that they cannot afford to quit.

Note the record of Santa Fe boys in winning the scholarship so generously provided for 14 years by the firm of Joseph T. Ryerson & Son. They have won it three times out of five. The best college men for railroads will be those from the ranks who win scholarships. This suggests the solution, and I believe the only solution, of the problem of college men on railroads. I hope the day will soon come when both large and small railroads will offer scholarships as prizes for their apprentices—in all departments. But some railroad organizations will change their methods of promotion if they are to hold such men afterward.

The speaker omitted to state that the Santa Fe success is due to the inspired individuals who started it and who had lived with it, as John Purcell, J. W. Kendrick, W. B. Storey and F. W. Thomas have done. Its foundation was laid many years ago when John Purcell formed his apprentices at the Fort Madison shops into a class of which he was the instructor. The class met nights and the instructor personally supplied accommodations, books and drawing materials. The larger work followed a single interview with the operating vice-president, J. W. Kendrick, who found ready support from President Ripley. It acquired fresh impetus and continued able support from Mr. Storey. Mr. Thomas did the work and he did and is doing it nobly, with Mr. Purcell as leader and counsellor and personal director. Inspiration at the top of the organization is the starting point. Many failures occur for lack of this essential. When the man higher up pounds the table and says, "I must have trained men. I'll discharge any officer who will not at once begin to train his own successor"—then you are ready to begin. The next step is to find an F. W. Thomas.

The new apprenticeship has proved itself. This, however, is only the beginning. Its field is every department and every office in the organization. When this truth is known railroads will come into their own. They will have better men and will keep their best ones, and what is more, employers and employees will better understand each other.

You are not advising your own son or the son of your best friend to enter the mechanical department of a railroad for a career. Think deeply of this. It is my opinion that Mr. Thomas has the solution of the question—"What is the matter with the mechanical department?"

C. W. Cross (vice-president Equipment Improvement Company): The educating and training of young men in all departments of railway service is so tremendously important that it demands the best thought and effort of those in charge of the administration of our railroads. The Santa Fe plan, both as a whole and in its details, is excellent, but may have to be modified in some respects to meet local conditions. As is evidenced from Mr. Thomas' paper, the providing of a successful plan for apprenticeship is only a part of the task. The greatest measure of real profit to the railroad will be realized only when conditions are such as to attract and hold the graduate apprentice in service. It will be contended that the railroads cannot afford to meet the competition for skilled mechanics on the part of industries in manufacturing districts. Obviously the railroads must have a good supply of skilled mechanics if they are to operate efficiently and economically. It will be necessary to pay the graduate apprentices on the same basis as journeymen. Not only this, but the more deserving and ambitious ones must realize that they will be advanced to subordinate administrative positions if they make good. While the average boy has been accused of giving too much weight to immediate financial returns, such a statement is open to very serious question. In all probability, if conditions are made favorable and there is a spirit of enthusiasm in the organization and possibility for advancement, he will realize its importance and take it into consideration when more attractive financial inducements are offered him elsewhere.

The best results can only be obtained when such conditions confront the graduate apprentice and when the entire plan of apprenticeship is handled in a dignified, businesslike manner, with no appearance of paternalism, and with a thorough understanding that the company expects and demands expert service from those training for the work, for which it is willing to pay liberally.

Jacob H. Yoder, supervisor of apprentices, Pennsylvania Railroad, briefly outlined the Pennsylvania system of apprenticeship and emphasized the fact that it is designed primarily to provide an adequate supply of mechanics for the shop, rather than recruits for promotion. The apprentices are divided into three classes: regular, first class and special. The first class is made up of the exceptional regular apprentices, who are selected for broader training, including car work, locomotive firing, etc., these men being available for promotion to minor positions of responsbility. Members of this class are furloughed to attend college if they so desire and may return to the road as special apprentices. Special apprentices are college graduates.

E. R. Larsen, supervisor of apprentices, D. L. & W., spoke of the necessity of education in the broad sense, the methods of acquiring it, whether in college, through a correspondence school or through one's own personal efforts not being of prime importance. He stated it as his belief that the best results from college trained men may be obtained if they serve a regular apprenticeship course first and receive their college education afterwards.

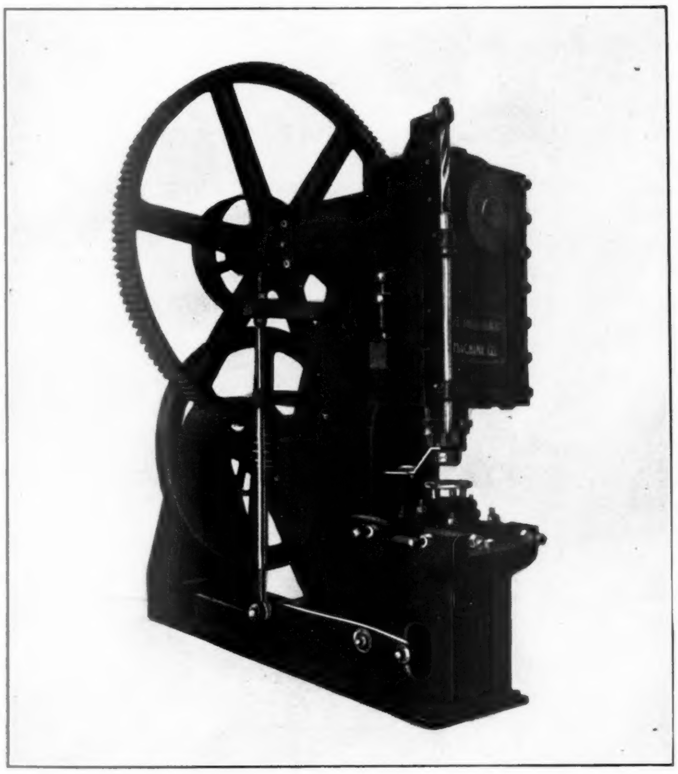
In closing the discussion, Mr. Thomas stated that the entrance requirements for the regular apprenticeship course on the Santa Fe are very flexible, an applicant who has had the advantages of a high school education being examined much more rigidly than one who has not been beyond the grammar schools, the purpose being principally to discover how he has availed himself of his opportunities. He also emphasized the importance of providing ample shop instruction. This cannot be left to the foremen, who are usually too busy with other duties directly bearing on the output of the shop to give much attentiton to the work of the apprentices. Shop instructors are therefore necessary.

New Devices

PUNCH PRESS FOR MAKING WASHERS

In the illustration is shown a punch press which has recently been designed by the Southwark Foundry & Machine Company, Philadelphia, Pa., especially for the manufacture of washers from scrap plate. The machine may also be used for various forms of stamping, punching, shearing, etc. Its most useful field, however, is in the utilization of waste material by the manufacture of washers, the special die construction providing for the completion of a washer at each stroke of the ram. In this way, the concentricity of the hole with the outer circumference is insured.

The frame is one solid casting of the open gap type on which is mounted the gearing, plunger, cam shaft, dies, etc. The plunger has broad wearing surfaces and is equipped



Punch Press Designed Especially for Making Washers from Scrap

with a bronze taper gib to take up wear. At its bottom are fastened the die and piercer, the former for cutting the outside of the washer and the latter for punching simultaneously the center hole. The punch is on the bottom and is held in a substantial punch holder block on the lower jaw of the frame. Surrounding this punch is the stripper ring, which, through connecting rods and lever, is operated from a cam on the back of the main shaft. In an annular space between the piercer and the die are a series of knockout pins for knocking down the washer, which sticks in the upper part of the die mechanism and goes up with the upward stroke of the plunger. These pins are operated by a bar passing cross-wise through the ram and at the top of the stroke stopping against a pair of set screws in lugs cast on the frame.

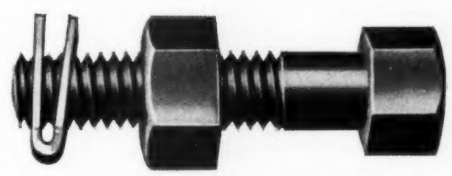
At the left side of the machine is a vertical shaft which is splined at the top with a steep pitch thread. This passes through a nut which is fast to the top of the plunger, the up-and-down stroke of the ram imparting a rotary motion to the shaft. On the bottom of this shaft is the hand or cup which receives the knocked-out washer and throws it into a pile or suitable receptacle.

In addition to the flywheel shaft, the back of the main shaft is also equipped with a tight pulley, which permits the machine to be driven direct, without the intervention of the gear reduction when handling light work. The speed of production is thus limited only by the skill of the operator handling the material.

The machine is made in five sizes, the capacities of which range from ½-in. to 3-in. bolt size, and when provided with direct motor drive, power requirements range from a 5-hp. to a 15-hp. motor. Where desired, the presses may be equipped with a roller feed mechanism for automatically feeding washer stock in bands or bars.

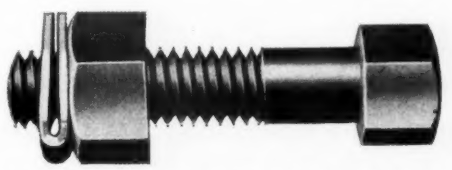
SPRING NUT LOCK

A simple spring nut lock, which is designed to replace the ordinary type of jam nut, has recently been brought out by the Industrial Development Corporation, Chicago. The device consists of two octagonal plates of thin steel, which are stamped from the sheet in one piece, a connection being pro-



The Loose Nut Lock Applied to the Bolt

vided between adjoining sides of the octagons. The plates are first stamped from the sheet, after which a circular hole is punched in each octagon of a size to fit the bolt for which it is intended. The plate is then bent until the two holes are almost in line, one being slightly offset from the other.



Tightened Against the Nut, the Nut Lock Follows the Nut as It Is Set Up Against the Material

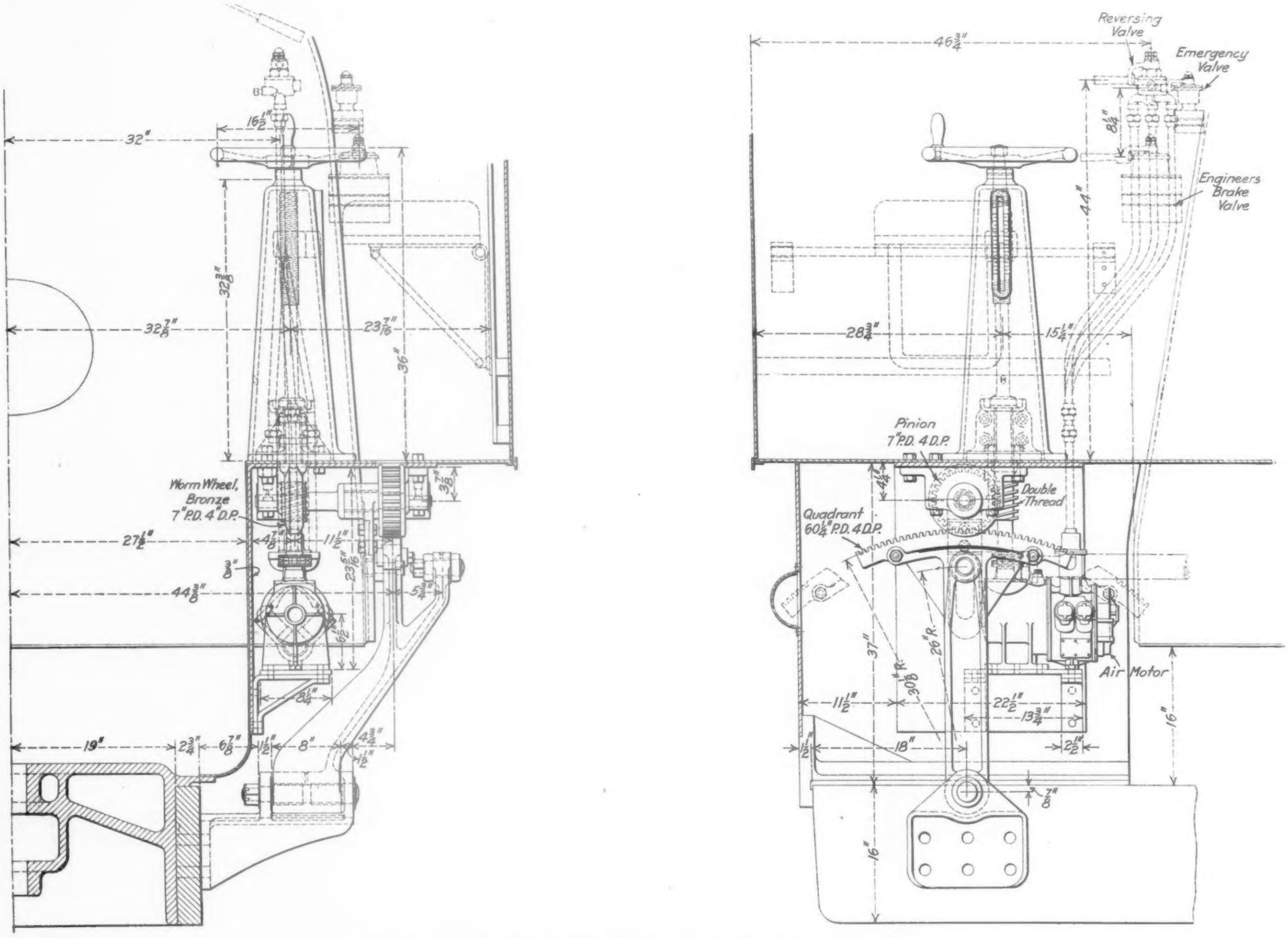
The connection between the two plates acts as a hinge and, after being tempered, provide a powerful spring action.

When the nut lock is slipped on the bolt and both legs engage the thread of the screw, the holes in the two parts are forced into perfect alignment against the action of the

spring connection, which exerts a powerful pulling force on one of the legs and a similar pushing force on the other. The leg on which the pulling force is exerted thus engages the valley of the thread on the side of the bolt opposite the spring, while the leg on which the pushing force is exerted, engages the valley of the thread on the side of the bolt adjacent to the spring. Tightened into place against the nut, the gripping on the threads thus produced is said to resist the action of vibration which tends to slack off the nut.

LOCOMOTIVE POWER REVERSE GEAR

An ingenious power reverse gear for use on locomotives has been invented by M. F. Cox, assistant superintendent of machinery, Louisville & Nashville, and is in use on the eight-wheel switching engines recently built by that road. This gear consists of a vertical shaft the lower end of which contains an integral worm that meshes with a bronze worm wheel located on a short horizontal shaft. On the opposite end of the horizontal shaft is a shrouded steel pinion meshing with a segment of a steel gear. This segment and the reach rod connection form one forked steel casting fulcrumed at the bottom to a substantial bracket and steel pin. This device may be operated either by hand or other power. The illustration shows the gear arranged for operation by an air motor the main spindle of which is connected at the base of the vertical worm shaft above mentioned by means of a flexible coupling. The motor is controlled and operated by a two-way valve conveniently attached to the boiler head within easy reach of the engineer and so arranged that the handle will be moved left to right for the forward movement of the engine, and the opposite direction for the backward movement. The wheel shown at the top of the vertical shaft is only used when it is desired to reverse by hand. It is readily removed and may be stowed away when the gear is being operated by power. The upper portion of the vertical shaft is threaded and fitted with an indicator nut which shows the engineer at a glance, the length of cut-off at which the engine is running. The scale for this indicator or pointer is located in full view on the outside of the reverse gear housing. This feature, of course, is of greater importance on road engines as switchers seldom, if ever, operate except in the corners. It requires 14 revolutions of the vertical shaft to bring the engine from full gear forward to full gear backward. With the air motor and 45 to 50 lb. air pressure, this can be accomplished in a few seconds. Its operation is smooth and noiseless. Its advantages are recognized over the old method often requiring 100 to 150 reversals during the course of a day, and the attention of the engineer diverted from the tracks, while struggling to reverse a heavy, stiff gear. Patent for this gear is now pending.



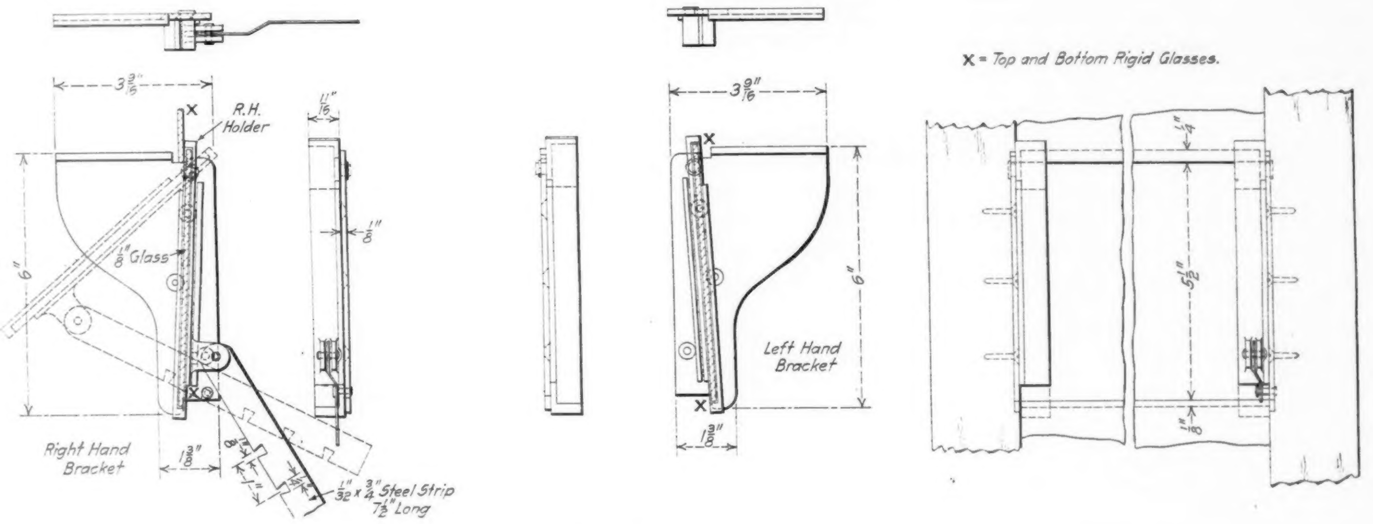
Power Reverse Gear Developed on the Louisville & Nashville

EFFECT OF ROLLING ON STRENGTH OF BRASS.—The tensile strength of test pieces taken from steel and iron sheets in the direction of rolling is greater than that of test pieces taken at right angles to the direction of rolling. In general, the reverse of this is true with test pieces taken from rolled brass. Further, the greater the reduction of the brass sheet by rolling the greater the comparative strength of the test piece taken across the grain.—*American Machinist.*

CLEAR VISION CAB WINDOW

A clear vision cab window which meets the requirements of the new federal government ruling has been designed and a patent applied for by F. Hopper, master mechanic of the Duluth, Winnipeg & Pacific, Duluth, Minn. The drawing shows the details of the window's construction and its application to front cab windows.

It is necessary in applying this window to cut a hole in the cab window in the direct line of the engineman's vision. This hole is made the full width of the window and 5½ in. deep.



Details and Application of Clear Vision Window to Front Cab Windows

The brackets, which are applied to the side frames of the window, contain a piece of glass 5⅞ in. deep and of a width to suit the width of the cab window and the space taken by the brackets. The glass in the clear vision window overlaps that of the cab window at the top on the inside ¼ in. and at the bottom on the outside ⅛ in. An operating handle is provided to move the window into whatever position is desired and when it is closed direct air currents, rain and snow are excluded because of the overlap at the top and bottom. It is advisable to place tape on the ends of the glass before placing it in the holders. There are no cross pieces of wood or metal in the cab window to obstruct the view of the engineman; even with the clear vision window applied the complete area of the window glass remains. The window is inexpensive to make; there are only four small metal parts which may be made of brass, pressed steel or malleable iron. It is easily applied and the cost of application is small. Windows of this type are in service on the Duluth, Winnipeg and Pacific and the enginemen on that road express themselves as greatly pleased with them.

PREPARATION FOR LEATHER BELTS

The Duntley Company, Chicago, has placed on the market a preparation called Soldco for leather belts, that is claimed to materially increase the life of the belt. The principal ingredient is a product that is used in the manufacture of Russian leather. Soldco is non-volatile, non-inflammable and non-combustible. It contains no acid and remains liquid under all atmospheric conditions. From tests made by the Griffin Wheel Company, of Chicago, it was found that this material does not contain rosin, mineral oil, acid or soap. It was found that it readily penetrates the leather, keeping it pliable, without producing an oily surface. It was also found that belts treated with Soldco would operate equally well in dusty or hot places as in cool and clean places. It was further found that the average slippage on belts treated with this preparation was reduced from 4 per cent to 2.02 per cent. It is further claimed by the company that Soldco will make the leather to which it is applied impervious to moisture or chemical fumes.

BOYER PEDESTAL RIVETER

A pedestal machine for riveting small, light parts, which can best be handled in a stationary machine, has been designed by the Chicago Pneumatic Tool Company, Chicago. The machine is operated by a foot lever, leaving the operator's hands free to handle the work.

The yoke consists of a crucible steel frame mounted in

Foot-Operated Pedestal Riveter for Light Parts

the end of a pipe column, the whole being supported on a cast iron base and held together with a ¾-in. bolt. The base is provided with anchor bolt holes to permit securely

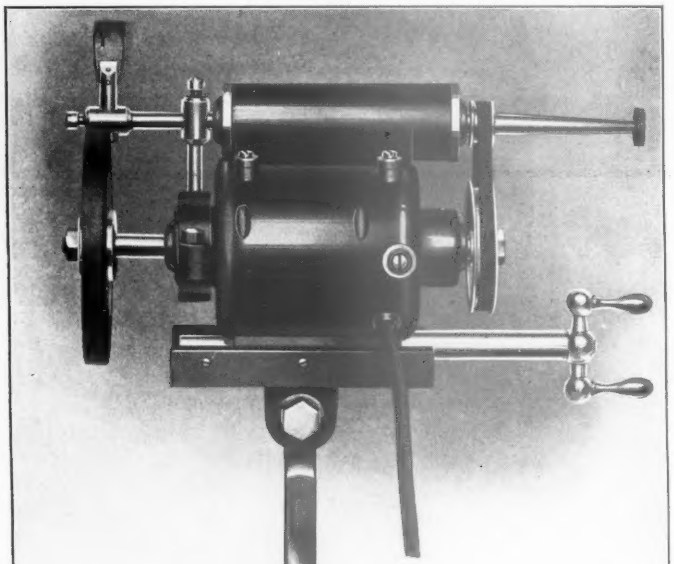
fastening it to the floor. The standard yoke has a gap of 8 in. and a reach of 11 in., but additional yokes may be had for any desired dimensions to accommodate larger work. Where it is desirable to handle more than one size rivet, a special dolly may be supplied that will accommodate four different sizes. This dolly is made to permit of its being used in very close corners and it can be replaced at reasonable cost when worn out.

The riveter head is a standard Boyer riveter, either 1 1/16-in. by 3-in., 1 1/16-in. by 4-in., or 1 1/16-in. by 5-in., and is held in a clamp which provides for adjusting it to take care of the wear on the dies as well as any variation in the length of the rivets. The net weight of the machine when equipped with the 1 1/16-in. by 3-in. riveter is approximately 173 lb.

DUMORE PORTABLE GRINDER

The Wisconsin Electric Company, Racine, Wis., has placed on the market a portable grinder which may be used for a large variety of purposes in the machine shop and tool room. This grinder weighs 17 lb. and is designed to be used in lathes, milling machines, shapers, etc. It is operated direct from the lamp circuit, having a universal motor which permits it being used with alternating current as well as direct current.

It comes provided with seven grinding wheels, ranging from 3/8 in. to 4 1/2 in. in diameter. It is provided with two spindles, one of which is used for surface grinding and the other for internal grinding. The speed of the spindle for



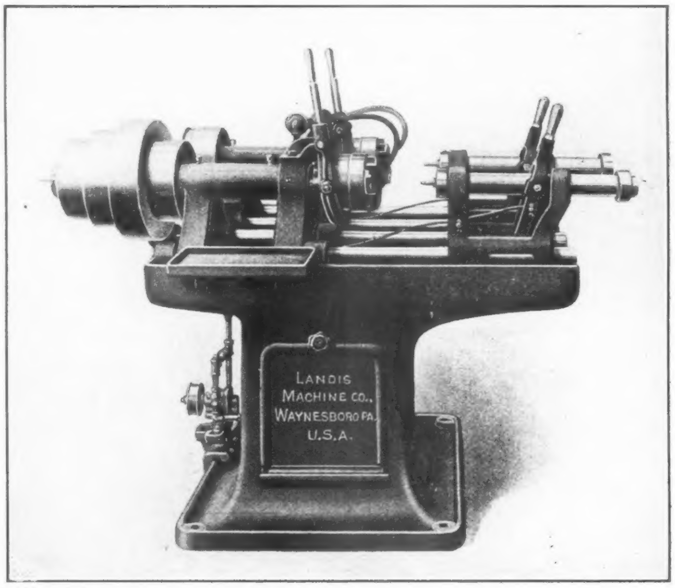
Portable Electric Grinder

the external grinding is 10,000 r.p.m., and that of the internal grinding spindle is 30,000 r.p.m. The armature, pulleys and grinding wheels are dynamically balanced, thereby eliminating any vibration in the motor, and leaving the ground surface free from chatter marks. This grinder can be used for grinding lathe centers, milling cutters, longitudinal and cylindrical grinding, internal grinding, and is especially adapted for small work difficult to machine, yet where accurate surfaces are required. It is provided throughout with S.F.K. ball bearings and it is provided with a cross feed which moves the motor longitudinally with its grinding wheels.

THREADING MACHINE FOR HOLLOW SET SCREWS

A threading machine has recently been placed on the market by the Landis Machine Company, Waynesboro, Pa., which is equipped with special carriages for threading hollow safety set screws. While primarily designed for this class of work, they may be employed in threading stock where there is a continuous thread and a similar method of holding.

The carriages proper are stationary and support two spindles which have a free, horizontal movement. These spindles are brought to the threading die heads by means of weights which are attached by chains to the levers operating the spindles. These weights exercise a constant force upon



Landis Hollow Set Screw Threading Machine

the spindles in the direction of the die heads, making it unnecessary for the operator to advance the stock for the threading operation. The heads of the spindles are bored and fitted with mandrels for holding the set screws. A collar is placed on the rear of each spindle, making it adjustable for cutting any desired length of thread. For the threading operation the set screw is placed upon the mandrel and the spindle automatically forces it into the die head. When the screw is threaded, it remains in a tube which extends through the spindle from the face of the threading die head to the rear of the machine. The subsequent threading of screws forces the finished pieces through the tube, from which they drop into a receptacle placed at the rear of the machine.

These machines may also be used for threading standard bolts by attaching automatic opening and closing attachments for the die heads. When standard bolts are threaded, the heads of the spindles on the carriages are fitted with bolt sockets for the various diameters within the range of the machine. These machines are equipped with Landis all steel die heads which employ long-life chasers.

INCREASE IN PRODUCTION OF STEEL PIPE.—A special statistical bulletin has been issued by the American Iron and Steel Institute showing the production of iron and steel skelp in the United States from 1905 to 1915 inclusive. In 1905, of a total production of 1,435,995 gross tons, 452,797 tons were of iron and 938,198 tons of steel. In 1915 the total production was 2,299,464 gross tons, of which 262,198 tons were of iron and 2,037,266 tons of steel.

Railway Mechanical Engineer

(Formerly the RAILWAY AGE GAZETTE, MECHANICAL EDITION *with which the* AMERICAN ENGINEER *was incorporated)*

PUBLISHED ON THE FIRST THURSDAY OF EVERY MONTH BY THE
SIMMONS-BOARDMAN PUBLISHING COMPANY

EDWARD A. SIMMONS, *President* L. B. SHERMAN, *Vice-President*
HENRY LEE, *Vice-President and Treasurer* M. H. WIUM, *Secretary*
WOOLWORTH BUILDING, NEW YORK, N. Y.
F. H. THOMPSON, *Business Manager*, CHICAGO.

Chicago: Transportation Bldg. Cleveland: Citizens' Bldg.
Washington: Home Life Bldg.
London: Queen Anne's Chambers, Westminster.

ROY V. WRIGHT, *Editor*
A. C. LOUDON, *Managing Editor*
R. E. THAYER, *Associate Editor* C. B. PECK, *Associate Editor*

Entered at the Post Office at New York, N. Y., as mail matter of the second class.

Subscriptions, including the eight daily editions of the *Railway Age Gazette* published in June in connection with the annual conventions of the Master Car Builders' and American Railway Master Mechanics' Associations, payable in advance and postage free: United States, Canada and Mexico, $2.00 a year; Foreign Countries (excepting daily editions), $3.00 a year; Single Copy, 20 cents.

WE GUARANTEE that of this issue 8,700 copies were printed; that of these 8,700 copies, 7,532 were mailed to regular paid subscribers, 112 were provided for counter and news companies' sales, 548 were mailed to advertisers, exchanges and correspondents, and 508 were provided for new subscriptions, samples, copies lost in the mail and office use: that the total copies printed this year to date were 91,600, an average of 8,327 copies a month.

The RAILWAY MECHANICAL ENGINEER is a member of the Audit Bureau of Circulations.

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CONTENTS

The department of safety of the St. Louis-San Francisco has extended the scope of its work by the appointment of two new safety inspectors, David Smith and W. F. Morrison. Mr. Smith will study shop conditions and Mr. Morrison train service.

MEMORIAL TABLET TO WILLIAM O'HERIN

On Saturday, October 7, a memorial tablet to William O'Herin, former superintendent of motive power of the Missouri, Kansas & Texas, was unveiled at Parsons, Kan., in the presence of thousands of employees. The tablet is placed between the passenger station and the general office building.

Mr. O'Herin was connected with the Missouri, Kansas & Texas for more than 41 years, joining that organization as an engineer and rising through various positions to superintendent of motive power. It was in this capacity, and while superintending the clearing of a wreck that he received the injuries which resulted in his death some months later, in 1914. The veil covering the memorial was raised by the Misses Kathleen and Ellen O'Herin, nieces of Mr. O'Herin. Following the unveiling, John S. Leahy, a prominent attorney of St. Louis, delivered an address. W. E. Williams, general manager of the M., K. & T., north of the Red river, followed Mr. Leahy and spoke on the life and work of Mr. O'Herin. The memorial tablet cost about $2,000 and was bought with funds raised among Mr. O'Herin's many warm admirers and friends in the ranks of the Missouri, Kansas & Texas Railway organization.

CARS AND LOCOMOTIVES ORDERED IN OCTOBER

The orders for cars and locomotives reported during the month of October made the month, despite the high prices for such equipment, one of the best thus far this year. Prices are so high, however, that there can be little doubt that such

purchases as are being made are only those that are absolutely necessary.

The totals of orders reported during the month were as follows:

	Locomotives	Freight cars	Passenger cars
Domestic	87	21,034	112
Foreign	181	......	...
Total	268	21,034	112

The important orders for locomotives included the following:

Road	No.	Type	Builder
Buffalo, Rochester & Pittsburgh	10	Mikado	American
	5	Mallet	American
Chesapeake & Ohio	25	Mallet	American
Western Maryland	10	Mallet	Lima
Wheeling & Lake Erie	10	Mallet	American
British War Office	100	2-6-2 tank	American
Finland State Rys	20	Consolidation	American
Orleans Ry. (France)	50	Mikado	American

The orders for freight cars included the following:

Company	No.	Type	Builder
Chesapeake & Ohio	1,000	Hopper	Std. Steel
	500	Hopper	Pressed Steel
	500	Hopper	Ralston
Chicago & North Western	500	Ore	Pullman
	1,000	Gondola	Pullman
	1,500	Box	Am. C. & F.
Louisville & Nashville	1,000	Gondola	Pressed Steel
	500	Hopper	Pressed Steel
Missouri Pacific	1,500	Gen. Ser.	Am. C. & F.
New York Central	2,000	Gondola	Am. C. & F.
	1,000	Box	Am. C. & F.
	2,000	Gondola	Std. Steel
Union Tank Line	500	Tank	Pressed Steel
	500	Tank	Std. Steel
	1,000	Tank	Am. C. & F.
	250	Tank	Co. shops
Western Maryland	2,000	Hopper	Pullman
Wheeling & Lake Erie	500	Gondola	Pressed Steel
	500	Gondola	Std. Steel

The passenger car orders included the following: Chesapeake & Ohio, 10 coaches, 1 dining and 2 parlor cars, American Car & Foundry Company; Great Northern, 15 postal cars, Pressed Steel Car Company; Louisville & Nashville, 6 coaches, 4 horse and baggage cars and 4 baggage and mail cars, American Car & Foundry Company, and Long Island, 15 coaches and 45 trailer cars, Pressed Steel Car Company.

MEETINGS AND CONVENTIONS

Association of Manufacturers of Chilled Car Wheels.—At the annual meeting of this association, in New York, on October 17, the following officers were elected: George W. Lyndon, president and treasurer; E. F. Carry, Haskell & Barker Car Company, vice-president; J. A. Kilpatrick, Albany Car Wheel Company, vice-president; Geo. F. Griffin, secretary, and F. K. Vial, Griffin Wheel Company, consulting engineer.

Railroad Section, A. S. M. E.—The meeting of the Railroad Section of the American Society of Mechanical Engineers, which will be held in New York City, Friday morning, December 8, promises to be a big success. Two of the papers which will be presented are printed elsewhere in this issue—one, by Thomas L. Burton, on Clasp Brakes and one, by A. F. Batchelder, on Mechanical Design of Electric Locomotives. A third paper on Pulverized Fuel for Locomotives will be presented by J. E. Muhlfeld. A large number have already signified their intention of attending the meeting and discussing the papers.

Smoke Prevention Association.—At the eleventh annual convention of the Smoke Prevention Association, which was held at the Planters Hotel, St. Louis, September 26 to 29, the following officers were elected for the ensuing year: President, W. H. Reed, chief smoke inspector, City of Chicago; first vice-president, Marten Rooney, chief smoke inspector, City of Nashville, Nashville, Tenn.; second vice-president, W. L. Robinson, supervisor fuel consumption, Baltimore & Ohio; secretary-treasurer, A. A. Chambers, of the Smoke Inspection Bureau, City of Chicago. Columbus, Ohio, was chosen as the next convention city.

Car Foremen's Association of Chicago.—The Car Foremen's Association of Chicago held its annual meeting at the Hotel La Salle, Chicago, October 10, at which an entertainment program was provided for the members and their guests. During the past year the association has had an average attendance of 169 members. During the year 921 new members were enrolled in the organization, making a total membership of 2,535, which makes this association the largest body of car men in the country. The following officers were elected for the ensuing year: President, A. L. Beardsley, division master mechanic of the Atchison, Topeka & Santa Fe, Chicago; first vice-president, H. H. Estep, general foreman of the car department, Chicago & Eastern Illinois; second vice-president, E. G. Chenoweth, mechanical engineer for the car department, Chicago, Rock Island & Pacific; treasurer, M. F. Covert, assistant master car builder, Swift Car Lines, and secretary, Aaron Kline, 841 Lawler avenue, Chicago.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations:

AIR BRAKE ASSOCIATION.—F. M. Nellis, Room 3014, 165 Broadway, New York City.

AMERICAN RAILROAD MASTER TINNERS', COPPERSMITHS' AND PIPEFITTERS' ASSOCIATION.—O. E. Schlink, 485 W. Fifth St., Peru, Ind.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.—J. W. Taylor, Karpen Building, Chicago.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—Owen D. Kinsey, Illinois, Central, Chicago.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Prof. E. Marburg, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. Thirty-ninth St., New York. Annual Meeting, December 5-8, 1916, New York.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—Aaron Kline, 841 Lawlor Ave., Chicago. Second Monday in month, except June, July and August, Hotel La Salle, Chicago.

CHIEF INTERCHANGE CAR INSPECTORS' AND CAR FOREMEN'S ASSOCIATION.—W. R. McMunn, New York Central, Albany, N. Y.

INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION.—A. L. Woodworth, C., H. & D., Lima, Ohio.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—J. G. Crawford, 547 W. Jackson Blvd., Chicago. Convention, May, 1917, Chicago.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 1126 W. Broadway, Winona, Minn.

MASTER BOILERMAKERS' ASSOCIATION.—Harry D. Vought, 95 Liberty St., New York.

MASTER CAR BUILDERS' ASSOCIATION.—J. W. Taylor, Karpen Building, Chicago.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION OF U. S. AND CANADA.—A. P. Dane, B. & M., Reading, Mass.

NIAGARA FRONTIER CAR MEN'S ASSOCIATION.—E. N. Frankenberger, 623 Brisbane Building, Buffalo, N. Y. Meetings, third Wednesday in month, New York Telephone Bldg., Buffalo, N. Y.

RAILWAY STOREKEEPERS' ASSOCIATION.—J. P. Murphy, Box C, Collinwood, Ohio.

TRAVELING ENGINEERS' ASSOCIATION.—W. O. Thompson, N. Y. C. R. R., Cleveland, Ohio. Convention was to have been held September 5-8, 1917, Hotel Sherman, Chicago. Postponed.

RAILROAD CLUB MEETINGS

Club	Next Meeting	Title of Paper	Author	Secretary	Address
Canadian	Nov. 14	Pulverized Fuel for Locomotives	J. S. Coffin, Jr.	James Powell	P. O. Box 7, St. Lambert, Que.
Central	Nov. 17	Locomotive Fuel Economy and Drafting of Locomotives	D. R. McBain	Harry D. Vought	95 Liberty St., New York.
Cincinnati	Nov. 14	Annual Meeting, and Banquet	....	H. Boutet	101 Carew Bldg., Cincinnati, Ohio.
New England	Nov. 16	Address	Howard Elliott	Wm. Cade, Jr.	683 Atlantic Ave., Boston, Mass.
New York	Nov. 17	Water Powers of Canada—Moving Pictures	L. O. Armstrong	Harry D. Vought	95 Liberty St., New York.
Pittsburgh	....	....	....	J. B. Anderson	207 Penn Station, Pittsburgh, Pa.
Richmond	Nov. 13	Annual Meeting; Election of Officers	....	F. O. Robinson	C. & O. Railway, Richmond, Va.
St. Louis	Nov. 10	Mechanical Stokers for Locomotives	W. S. Bartholomew	B. W. Frauenthal	Union Station, St. Louis, Mo.
South'n & S'w'rn.	Nov. 16	Fire Prevention; Election of Officers	....	A. J. Merrill	Box 1205, Atlanta, Ga.
Western	Nov. 20	....	....	Jos. W. Taylor	1112 Karpen Bldg., Chicago.

Personal

GENERAL

William Kelly, general master mechanic of the Great Northern at Spokane, Wash., has been appointed assistant superintendent of motive power, with headquarters at Spokane, and jurisdiction over the Central and Western districts.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

Bertron H. Davis, who has been appointed assistant master mechanic of the Delaware, Lackawanna & Western at Scranton, Pa., was born in Ithaca, N. Y., October 9, 1873. After receiving a common school education he entered railroad service in March, 1890, as a machinist helper in the locomotive shops of the Delaware, Lackawanna & Western at Scranton. In May, 1893, he became a locomotive fireman and was promoted to engineman in November, 1901. He ran an engine until September, 1911, when he was appointed assistant road foreman of engines, about a year later becoming road foreman of engines. He continued to serve in this capacity until his recent appointment.

N. C. Bettenburg, who has been appointed master mechanic of the Great Northern at Minot, N. Dak., was born in St. Cloud, Minn., January 14, 1872. He received his education in the district school and began his railroad career in December, 1890, with the St. Paul & Duluth. In December, 1895, he entered the service of the Great Northern as a machinist at St. Paul, Minn. He remained here until 1901, when he was appointed general foreman, serving in this capacity at Barnesville, Melrose and St. Paul. He was subsequently appointed master mechanic and traveling master mechanic, being transferred to the Minot division on October 1, as above noted, when the latter office was discontinued.

N. C. Bettenburg

J. J. Dowling has been appointed master mechanic of the Great Northern, with headquarters at Delta, Wash.

B. J. Farr has been appointed master mechanic of the Grand Trunk, western lines, with headquarters at Battle Creek, Mich., in place of W. H. Sample, transferred.

F. M. Fryburg has been appointed master mechanic of the Great Northern, at Great Falls, Mont.

A. H. Kendall has been appointed master mechanic of the Canadian Pacific at Toronto, Ont., succeeding W. J. Pickrell, transferred.

T. J. Raycroft, assistant master mechanic of the Cumberland division of the Baltimore & Ohio, has been appointed master mechanic of the Wheeling division, with headquarters at Wheeling, W. Va., succeeding James Bleasdale, resigned, to accept service elsewhere.

Frank H. Reagan, superintendent of shops of the Delaware, Lackawanna & Western at Scranton, Pa., has been appointed master mechanic of the Scranton, the Syracuse & Utica and the Bangor & Portland divisions, succeeding George Durham, resigned to go to another company.

William R. Elmore, recently appointed master mechanic of the Nevada Northern, with headquarters at East Ely, Nev., was born at Greers, S. C., on October 14, 1867. He first entered railway service with the Nashville, Chattanooga & St. Louis in March, 1895, as an air brake machinist in the locomotive and car department. He remained with this company until 1903, following which he served as machinist with the Southern at Atlanta, Ga., and Birmingham, Ala., with the Louisville & Nashville at Birmingham, with a steel works at Pueblo, Colo., and with the Denver & Rio Grande at Alamosa, Colo. He was here made erecting shop foreman in November, 1910, three years later being transferred to the Utah lines as general foreman at Salt Lake City. He remained here until March 1, 1915, when he entered the service of the Nevada Northern as general foreman.

W. R. Elmore

PURCHASING AND STOREKEEPING

Harry P. Spann has been appointed division storekeeper of the Atchison, Topeka & Santa Fe, at River Bank, Cal., succeeding G. O. Hixon, who has been transferred.

OBITUARY

Theodore N. Ely, formerly chief of motive power of the Pennsylvania Railroad System, including the lines both east and west of Pittsburgh and Erie, who retired from railway work on July 1, 1911, after 43 years of service, died on October 28, at his home in Bryn Mawr, Pa., aged 70.

William McWood, formerly superintendent of the car department of the Grand Trunk, from which position he retired on a pension in 1908, died on October 4, after a long illness. He was born in 1830 at Montreal, Quebec, and served an apprenticeship with John Thorton, coach builder. He entered the services of the Grand Trunk in 1855, and from 1860 to 1873 was foreman on the same road. He then served as assistant mechanical superintendent and superintendent of the car department of the same road, in charge of the car department of the entire line from 1873 until his retirement on January 1, 1908, after a continuous service of 53 years with the Grand Trunk. Mr. McWood took a very active part in the organization of the Master Car Builders' Association, having been a member of that association since 1875. From 1882 to 1887 he served as vice-president, and for the three years 1888, 1889 and 1890 as president.

W. McWood

SUPPLY TRADE NOTES

The Greenfield Tap & Die Corporation, Greenfield, Mass., has discontinued its store in Detroit, Mich.

D. P. Lameroux has been appointed general manager of the Pratt & Letchworth Company, Ltd., Brantford, Ont.

G. L. Simonds & Co., Chicago, have changed their name to the Vulcan Fuel Economy Company. The personnel and policies of the organization remain the same.

Stanley H. Smith, of the sales staff of the Bethlehem Steel Company, at Chicago, Ill., has been appointed sales agent of the Cleveland district, with office at Cleveland, Ohio.

The H. W. Johns-Manville Company, New York, announces that Harry Flanagan, formerly with the Grip Nut Company, will represent its railroad department in the Twin City territory.

The U. S. Light & Heat Corporation, Niagara Falls, N. Y., at a recent meeting of its board of directors, elected C. L. Lane vice-president. Mr. Lane was formerly secretary of the company.

John Hulst, chief engineer of the Carnegie Steel Company, has been appointed assistant to vice-president and chief engineer of the United States Steel Corporation, succeeding Marvin A. Neeland.

The R. & J. Dick Company, Inc., Passaic, N. J., opened a branch office at Atlanta, Ga., on October 1. This is the second new branch established during the year, the other being an office in Seattle, Wash., which was opened in January.

Marvin A. Neeland, assistant to vice-president and chief engineer of the United States Steel Corporation, has resigned to accept the position of consulting engineer of the American International Corporation, with headquarters at 120 Broadway, New York.

Dwight E. Robinson, formerly eastern railway representative of the Acme White Lead & Color Works, Detroit, has been elected vice-president and treasurer of Thornton N. Motley & Co., Inc., manufacturers' agents, Grand Central Terminal, New York.

Homer C. Johnstone, formerly with the Midvale Steel Company, has been appointed manager of the steel department of Gaston, Williams & Wigmore, Inc., New York. Mr. Johnstone served for 14 years as manager of the Chicago and New York offices of the Midvale Company.

The Jones & Laughlin Steel Company, Pittsburgh, Pa., intends soon to establish a large warehouse in St. Paul, Minn., to handle its greatly increasing northwest business. This company has extensive mine holdings in Minnesota and operates its own steamship line on the great lakes.

The H. W. Johns-Manville Company, New York, has opened a new branch office at Great Falls, Mont. The office is at room 418, Ford building, and is in charge of J. H. Roe. With the opening of the Great Falls office the H. W. Johns-Manville Company increases the number of its branches to 55.

C. R. Ahrens, formerly storekeeper of the Delaware, Lackawanna & Western, in charge of maintenance of way supplies, including signal materials, has resigned from his position, and become connected with the Signal Accessories Company, Utica, N. Y. His headquarters are at 30 Church street, New York.

The Harrison Railway Specialties Company, Chicago, Ill., has secured an order for Harrison dust guards for the 4,000 freight cars being built by the Bettendorf Company, of Bettendorf, Iowa, for the Russian government. The Harrison guard was passed upon and adopted by the Russian Imperial Railway Commission.

Charles Lounsbury has recently been made president and general manager of the American Railway Supply Company, 134 Charles street, New York City. Mr. Lounsbury was born in New York City in 1868 and is a graduate of the College of the City of New York. He began his business career in 1887 with the American Railway Supply Company as junior clerk and has been with that company in various capacities ever since.

The Burnside Steel Company, Chicago, Ill., has been incorporated with a capital stock of $100,000. It has purchased a tract of land at Ninety-second street and Kimbark avenue, and is erecting an 80-ft. by 200-ft. foundry building, a 30-ft. by 50-ft. office and pattern storage building, together with material bins, etc. It will produce steel castings and is installing a side blow converter. It will be ready for operation on December 1, this year. The office of the company is at 548 Railway Exchange building, Chicago. H. F. Wardwell is president, and C. S. Daniels, secretary.

H. W. Finnell, general manager of the Henry Giessel Company, Chicago, has been elected vice-president of Templeton, Kenly & Co., Ltd., Chicago, manufacturers of Simplex jacks. He will be in charge of sales and assumed his new position on October 1. Mr. Finnell started his business career in the rolling mills of the National Tube Company at McKeesport, Pa., in 1899. He worked his way into the sales department, but left the company in 1901 to enter the service of the Wheeling Steel & Iron Company. In 1904 he left the position of assistant sales manager of that company and tried his luck in the oil business in Indian Territory but without success. In 1906 he joined the sales department of the Chicago Railway Equipment Company, but in 1909 he became assistant sales manager of the Carbon Steel Company, later being sales manager and then assistant to the president and at the same time president of the Mosher Water Tube Boiler Company. Prior to October 1, he was general manager of the Henry Giessel Company, Chicago. He still retains his interest in that company.

H. W. Finnell

The Edgewater Steel Company, Pittsburgh, Pa., recently incorporated, has purchased the plant of the Kennedy-Stroh Corporation at Oakmont, Pa. In addition to carrying on the lines of manufacture in steel and brass, formerly handled at this plant, new construction is now under way to give this company a well equipped plant for the manufacture of locomotive and car wheel tires, rolled steel wheels, gear rims, roll shells and turbine rings. The officers are: President, F. B. Bell; vice-president, M. R. Jackson; treasurer, W. H. Schoen; secretary, J. H. Baily; general manager, F. C. Riddile.

G. A. White, formerly metallurgist of the American Sheet & Tin Plate Company, has become associated with the Titanium Alloy Manufacturing Company, Niagara Falls, N. Y., in the same capacity. Mr. White's long experience in the manufacture of sheet steels makes him a valuable addition to the metallurgical force of the Titanium company. Prior to his connection with the American Sheet & Tin Plate Com-

pany, Mr. White was for a considerable time with the Rock Island and also with the Eastern Steel Company, Pottsville, Pa., where he was engaged in the manufacture of structural material. It is, however, in the manufacture and treatment of sheet steel that Mr. White has done his most notable work.

J. P. Landreth, formerly Chicago manager of the Garlock Packing Company, Palmyra, N. Y., has been appointed western sales manager of the Anchor Packing Company, Philadelphia, Pa., with headquarters at Chicago. Mr. Landreth was born at Beloit, Kan., on August 11, 1883, and attended the public schools and a business college at Joplin, Mo., and the Missouri Military Academy at Mexico, Mo. His first business connection was with the Joplin (Mo.) Water Works Company as collector and inspector of accounts. Later he was employed as car clerk on the Denver & Rio Grande, at Salida, Colo., and in 1902 took a position with the English Iron Works, at Kansas City, Mo., where he gained a knowledge of steam railway specialties which qualified him for a sales position in this line in St. Louis. In the spring of 1904, he became associated with the Garlock Packing Company as traveling salesman and on January 1, 1905, was transferred to St. Louis, Mo., as city salesman. In the fall of 1906, he took charge of the Kansas City office of the same company, and in May, 1908, he was made Chicago manager.

J. P. Landreth

Robert Cochran McKinney, chairman of the board of directors of the Niles-Bement-Pond Company, Plainfield, N. J., died at his summer residence in Belle Haven, Conn., after an illness of more than two years. He was born at Troy, New York, but in 1861 he moved to Cincinnati where he attended the public schools and Woodward High School until eighteen years of age. He next took a partial course in mechanical engineering in Cornell University. His student life was followed by employment in the draughting room and office of a company which manufactured steam pumping machinery at Hamilton, Ohio. In 1877 Mr. McKinney became associated with the Niles Tool Works and within two years was elected secretary of the company. A short time later he became treasurer and general manager. While with this company he had gained the title of Colonel through his service on the staff of Governor Bushnell, of Ohio. During the reorganization of the Niles Tool Works, necessitated on account of the rapidly expanding business, Colonel McKinney was pre-eminent. In 1898 the Pond Machine Tool Company, Plainfield, New Jersey, was purchased, and options were obtained on the works of Bement, Niles & Company, Philadelphia, Pa., as well as the Philadelphia Engineering Works. Thus the present Niles-Bement-Pond Company, was created and Colonel McKinney was elected president of the company, in recognition of his achievement in creating and perfecting its organization.

Col. R. C. McKinney

The Willard Storage Battery Company, Cleveland, Ohio, announces the following appointments: Lester B. Knight, eastern representative, railway department, with headquarters at New York; E. L. Myers, western representative of railway department, with headquarters at Chicago, with jurisdiction over all territory west of the Ohio and Mississippi rivers, and I. R. Wentworth, representative of railway department at Chicago. Mr. Knight was, prior to September, 1915, chief electrician of electric car lighting on the Boston & Albany. Mr. Myers has been in the service of the Willard Storage Battery Company since December 1, 1913. From 1909 to 1913 he was chief electrician of the National Railways of Mexico.

William A. Austin, until recently connected with the Lima Locomotive Corporation, Lima, Ohio, as chief engineer, has formed a company called the Austin Engineering Associates, which has offices in the McCormick building, Chicago. This firm will conduct a general consulting engineering business, but will specialize chiefly on railway motive power and equipment. Mr. Austin was born in London, England, in 1874, and received his early education in a private school there. On coming to America, he continued his education in the public schools of Philadelphia, Pa., and then took up more advanced studies at the Technical High School in that city. His first service in railway work was with the Baldwin Locomotive Works, with which company he became connected in 1892, as draftsman. He was later made designer, assistant chief draftsman and assistant mechanical engineer. This last named position carried the entire duties of estimating engineer in charge of preliminary analyses, estimates, plans and general design in conjunction with the sales department. In 1912 he became associated with the Lima Locomotive Corporation as chief engineer in charge of all engineering design and estimating, and he also served as general field representative for the sales department in technical matters. During the period Mr. Austin was with the Baldwin Locomotive Works he participated directly in the development of the Mallet type of locomotive in this country, in the early application of the Walschaert valve gear to American locomotives and he was co-developer of the much used Ragonnet reversing gear. He also assisted the engineers of the Southern Pacific and Union Pacific systems in perfecting common locomotive standards for these lines. He is inventor of the Austin trailer-truck, successfully applied to many Lima locomotives for trunk line service. He has invented other devices used in locomotive construction, including a screw reverse gear adopted by the Southern Pacific, an outside steam pipe cover which is used on many superheater engines, a hose strainer coupling connection between engine

W. A. Austin

and tender, as well as improvements in rack-rail locomotives and gear-driven engines.

J. E. Buker, general sales manager of the Chicago Car Heating Company, Chicago, Ill., has been elected vice-president, effective October 15. He was born in Jefferson county, New York, where he received his early education. Upon leaving school, he entered the mechanical department of the Michigan Central, where he remained about twelve years. Seeing a chance to acquire some very special mechanical experience with another company he obtained employment with the Atchison, Topeka & Santa Fe. Two years later he accepted a position with the Hicks Stock Car Company, as general manager, with which concern he was connected nine years. He then became assistant superintendent of machinery of the Illinois Central, holding this position for eleven years. Following his resignation from this company in 1910, he became associated with the Chicago Car Heating Company.

Oliver J. Smith, whose appointment as manager of the Lima Locomotive Corporation, has recently been announced, was born January 20, 1883, at South Dayton, N. Y. After an elementary education in the public schools of his native town he entered the high school at Jamestown, N. Y. In July, 1899, he took employment with the American Locomotive Company as an apprentice, remaining with this company until 1906 when he went to the Lake Shore & Michigan Southern shops at Collinwood, Ohio, as an expert machinist. In 1907 he returned to the American Locomotive Company's plant at Dunkirk, N. Y. In 1910 he was promoted and transferred to the New York office of this same company as piece work supervisor, which position he held until August 1 of this present year, when his appointment as manager of the Lima Locomotive Corporation became effective.

W. P. Barba, vice-president of the Midvale Steel Company, Worth Brothers Company and the Wilmington Steel Company, has resigned, and the duties of vice-president of these three companies will be assumed by E. E. Slick, vice-president of the Cambria Steel Company. Mr. Barba will take a few months' rest and travel before taking up some special work along the lines of his wide experience at Midvale; he does not intend to undertake the same character of work that he is now relinquishing. Mr. Barba had been in the employ of the Midvale Steel Company for 36 years. Entering Midvale in 1880 as a boy, in nine years he was made chief chemist, then department superintendent, and not long after, general manager of sales. A few years ago he was made general superintendent, and upon the resignation of the general manager he was called upon to fill that position, which he held until he was made vice-president at the time of the taking over of the plant by the Corey interests.

Articles of incorporation have been filed in Delaware for the Inter-Continental Machinery Corporation with a nominal authorized capital stock of $500,000. It is understood that the new enterprise will deal in machinery in general, but specialize in machine tools both in the United States and foreign countries. The organization is headed by Charles N. Thorn, until recently vice-president of the Allied Machinery Company of America, which is now part of the American International Corporation. Mr. Thorn had been connected with Manning, Maxwell & Moore for 14 years. The other officers consist of Joseph S. Clark, of E. W. Clark & Co., Philadelphia; R. E. Robinson, of R. E. Robinson & Co., bankers, New York, and Chester B. Overbaugh, formerly manager of the Thompson-Starrett Company, Washington, D. C., vice-presidents, and Arthur M. Watkins, secretary. The company will establish branch offices in the principal countries of Europe, beginning with Russia, in which country the company will establish its branch in Petrograd, following with Moscow, Odessa and Vladivostok. An office and salesroom at Paris, France, and also one in London, will follow. It is also planned to open offices in China and Japan.

CATALOGUES

OIL ENGINES.—Bulletin No. 154, recently issued by the De La Vergne Machine Company, New York, describes the De La Vergne type "FH" crude oil engine.

PORTABLE TOOLS.—Bulletin E-44, recently issued by the Chicago Pneumatic Tool Company, describes the Duntley electric sensitive drilling stand and electric drill to fit sensitive drilling stands.

AIR COMPRESSORS.—Bulletin 34-Z, recently issued by the Chicago Pneumatic Tool Company, deals with the company's steam driven single compressors with balanced steam valve and automatic flywheel governor.

BURNING CRUDE OIL.—A booklet recently issued by the De La Vergne Machine Company, New York, says that in the De La Vergne oil engine one cubic inch of oil has 6,000 sq. in. of surface all exposed to the high temperature oxygen at the same instant.

WELDING AND CUTTING.—The Searchlight Company, Chicago, is now distributing catalogue No. 12 on Searchlight welding and cutting equipment. The booklet, to quote from its title page, is "A book of specific information on the welding and cutting of metals by the oxy-acetylene process, together with a catalogue of the equipment necessary for such work." There are many illustrations showing the Searchlight equipment and the work for which it is adapted.

RUBBER GOODS FOR RAILROAD SERVICE.—This is the title of a 48-page booklet which has recently been published by the B. F. Goodrich Company, Akron, Ohio. In it are described the various items of the Goodrich line, including a complete line of hose for fire protection, pneumatic tools, air brake, steam heat, etc.; belting for axle lighting sets, conveyor belts, transmission belts, rubber matting, interlocking tiling, gaskets, insulation, etc. The book is well illustrated and is gotten up in an attractive manner throughout.

HORIZONTAL POWER PUMPS.—Bulletin No. 201 of the National Transit Pump & Machine Company, Oil City, Pa., is a 20-page pamphlet devoted to the company's line of horizontal piston power pumps, which are designed to cover a wide range of general service. The pumps are designed either for belt or direct connection to the prime mover and are furnished direct connected to National Transit gas and oil engines of the vertical type. The pamphlet is a complete catalogue, giving sizes and dimensions of the various types.

TAPS AND DIES.—The Greenfield Tap & Die Corporation, Greenfield, Mass., has issued a booklet relative to the "Gun" tap which it has recently perfected and put upon the market. This tap is especially strong and efficient. Its cutting edges at the point are ground at an angle to the axis of the tap in order to cut with a shearing action. This throws the chips, unbroken, ahead of the tap instead of allowing them to collect in and clog the flutes. A two or three flute construction is thus possible and much shallower flutes are possible than in the ordinary tap. A description of the tap appeared in the *Railway Mechanical Engineer* for August, page 429.

SPRACO SYSTEM FOR COOLING CONDENSING WATER.—This is the title of a 16-page booklet recently issued by the Spray Engineering Company, Boston, Mass. In the "Spraco" system the hot water is cooled by spraying it into the air so that when it falls into the basin or pond, its temperature is sufficiently reduced to permit of its being used over again. The booklet describes the system in detail, showing its advantages and the economies derived from its use and a number of views are given of Spraco systems in operation. The same company has also issued two leaflets relating respectively to the "Vaughan Flow Meter" and 'Cooling Water for Ice Plants."